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Triple-Expansion Direct-Acting Pumping Engine at the Jamaica Station of the Brooklyn Water-works.

The water supply of Brooklyn, although, perhaps, satisfactory in the main, is decidedly complicated in its details. As the rapid growth of the city has, from time to time, called for an increased quantity of one of the prime necessities of life, various parts of Long Island have been put under requisition to supply the demand; pumping stations are constantly in process of construction, and by and by the ramification of water pipes contributing to that end will rival the web of a spider.

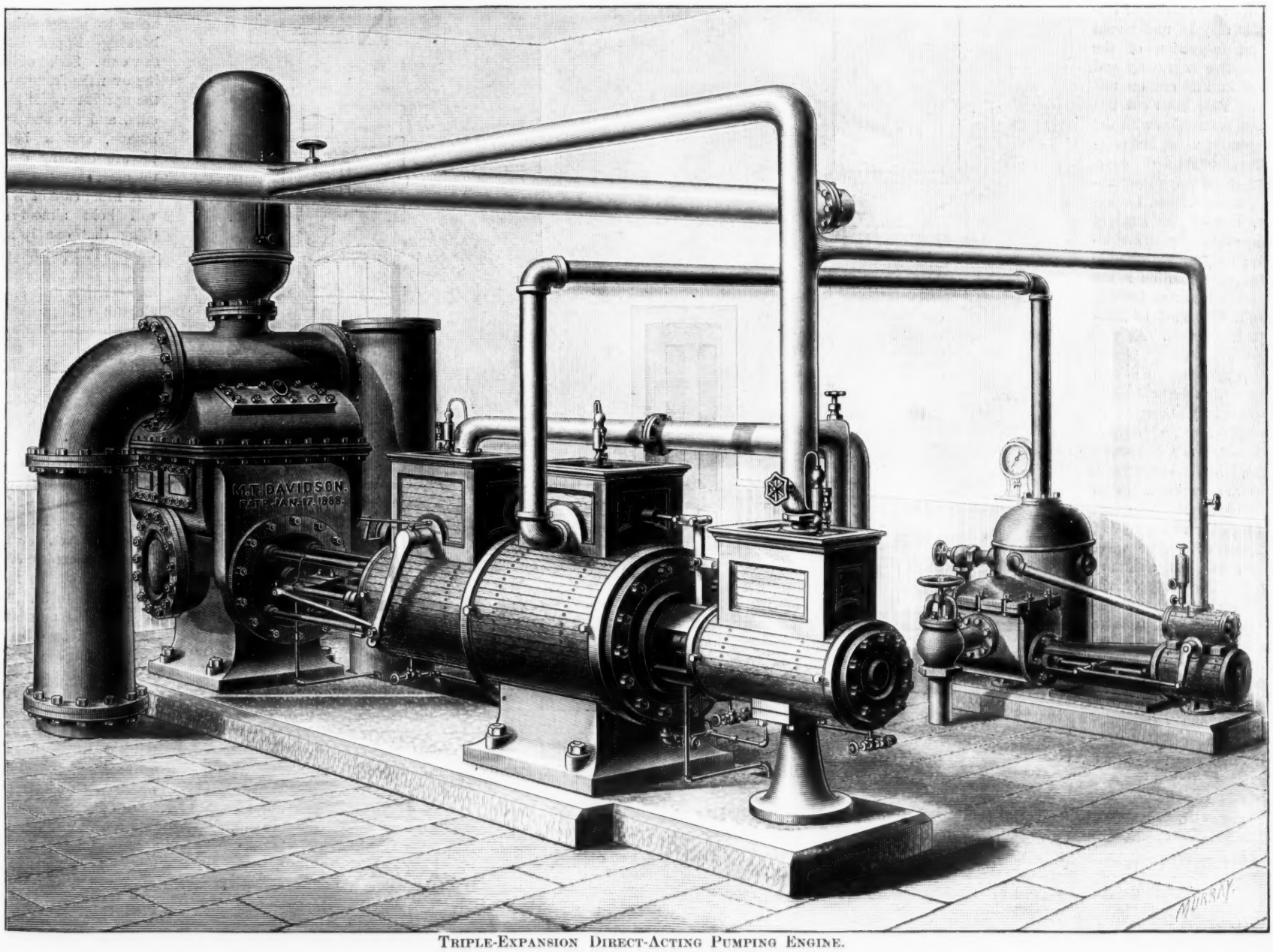
One of the latest stations is that at Jamaica. Here water is pumped from driven wells, and from a pond near by, and forced into the conduit which extends from further inland to the reservoir.

The water from the pond is pumped by a triple-expansion direct-acting pumping engine built by M. T. Davidson, 43 Keap street, Brooklyn, N. Y., an engraving of which is shown on this page.

The advent of the direct-acting steam pump, in which the crank and fly-wheel were dispensed with, and other means than an eccentric or crank motion employed to operate the steam valve was a matter of especial importance, inasmuch as it greatly simplified construction, and reduced weight and cost. For many purposes, and in small sizes, single cylinder pumps of this type give results entirely satisfactory. But where considerable quantities of water are to be handled, calling for pumps of such a size as to be denominated engines, the direct-acting pump with a single cylinder is undesirable, because steam must follow the piston practically full stroke, and all benefits due to expansion are lost. This consideration led to two-cylinder compound pumps in which expansion due to the difference in the capacities of the two cylinders is obtained. The gain from this is important; but, for reasons so well understood as to make reference to them unnecessary, it is limited.

But triple-expansion engines had proved themselves superior in ocean navigation, and why should not the same results obtain in the instance of direct-acting pumps? Manifestly it would permit of greater expansive working, which was desirable to the end of bringing about greater economy in the use of steam. And economy in the use of steam is particularly desirable in the instance of an engine likely to be in operation all the hours of the twenty-four.

Some such considerations as the foregoing may probably have led to the adding of the third cylinder to the direct-acting pumping engine herewith illustrated—this, together with a consideration of the fact that the additional cylinder could be placed without complication of parts.



TRIPLE-EXPANSION DIRECT-ACTING PUMPING ENGINE.

At first it might be thought that the three cylinders, tandem, would introduce an undesirable element—that of length—in a type of pumping engines in which the small space occupied is a strong feature; but this does not appear to be borne out by an examination of this engine. This is in part due to the means taken to bring the low-pressure and intermediate cylinders close together, without the necessity of a stuffing-box between them, which is accomplished, and at the same time outside stuffing-boxes are provided for all the rods, as will be further referred to.

The steam cylinders of this engine are 9″, 14″ and 24″ diameter, with a stroke of 24″. The low-pressure cylinder is in the center, with the intermediate cylinder next the pump, and the high-pressure cylinder at the outer end. The exhaust from the high-pressure cylinder is piped past the low-pressure cylinder, and to the intermediate cylinder, as shown, and from this cylinder the steam goes to the low-pressure cylinder, from which it passes to the independent air-pump and condenser, shown in the engraving at the right.

The advantages of an independent condenser are that it provides, by varying the speed of its pump, for handling just the amount of water necessary for condensing the steam; also it can be started before the main engine is started, thereby giving the latter the advantage of a vacuum in getting into motion.

The condenser for this engine is the same as those that have been made for some years by Mr. Davidson.

The water for condensing the steam is introduced by means of a perforated pipe, extending across the condenser, and by and through this water thus introduced, the exhaust steam must pass. Ample openings are provided, so that the minimum practicable opposition to ingress and egress of steam and water is introduced.

To provide for easier starting of the engine, there is a by-pass in the steam pipe, so that live steam can be introduced to the intermediate cylinder until the cylinders are warmed, and the engine is in regular motion.

We have previously referred to the arrangement by which the low-pressure and intermediate cylinders are brought close together. The following will explain: The rod of the intermediate piston carries a crosshead, and from near the outer ends of this crosshead two piston rods extend to the low-pressure piston (which, it will be remembered, is the center one of the three). These two rods pass through bronze sleeves, alongside the intermediate cylinder, inside the lagging, to the end of it. These sleeves are provided at their outer ends with ordinary stuffing-boxes, which are, as will be seen, entirely accessible. It is this feature that permits the low-pressure and intermediate cylinder to be placed close together, providing stuffing-boxes in plain sight, and at the same time saving space. From the piston of the low-pressure cylinder a single rod extends to the high-pressure piston, these two cylinders being far enough apart to admit of stuffing-boxes between them.

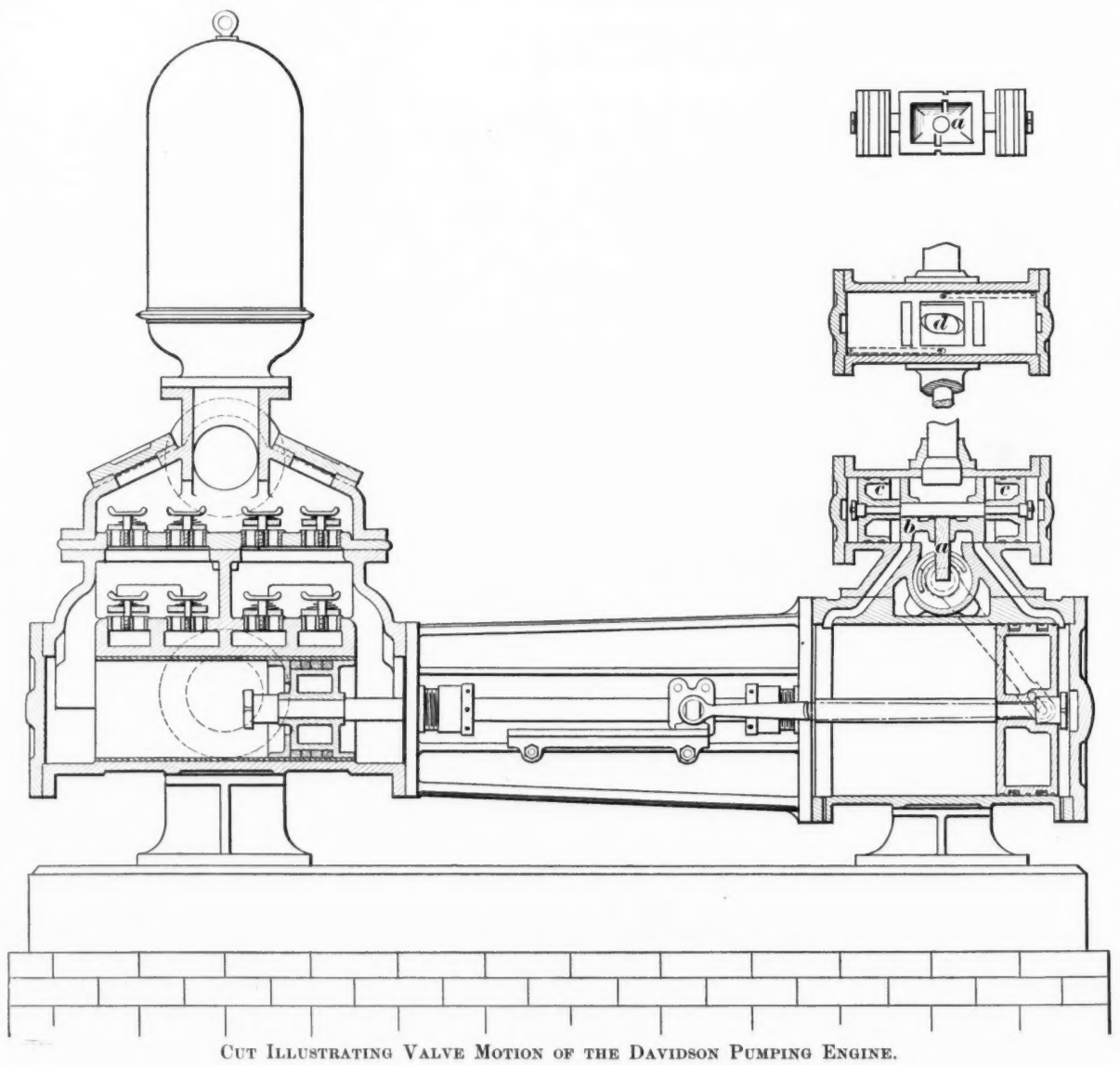
The valve motion of this engine may be understood by an inspection of the perspective engraving and of the outline cut on this page. This latter cut has no real connection with the perspective view, but is introduced to show the operation of the valve mechanism; it represents, in section, one of the small pumps made by this company; but, as the principle of the valve motion is the same in all pumps by this firm, it will serve to illustrate the action. As will be seen, the steam valve is driven by means of a connection from the crosshead. There is only one valve in the steam chest, which may be described as a compound valve, inasmuch as its functions are twofold. This valve has a cylindrical face, and it performs two duties, viz., that of a slide valve proper and an auxiliary valve. The duty of the auxiliary valve in direct-acting steam pumps is to admit steam to small pistons, which by their motion move the main steam valve to and fro, so as to admit steam to and exhaust i from the main cylinder.

Referring to the outline engraving, the valve *b* is driven by an oblique cam *d*. This cam will not only move the valve back and forth, but, owing to its conformation, it will give to the valve, at the proper time, an oscillatory motion that will, through small ports, admit steam to alternate ends of the auxiliary pistons *c*, thus bringing about a supplementary motion of the slide valve, as in the instance of all pumps of this type. The steel pin *a* forms the connection between the cam *d*, which is situated in the exhaust port, and the valve *b*. The proper motion of the main slide valve does not, however, depend entirely upon the action of the auxiliary pistons *c*. For if these pistons do not act quickly enough, or at abnormally high speed, or if the small ports become clogged, then the regular motion of the cam will operate the slide valve as if it were driven by an eccentric.

It should be understood that the arrangement of valves as described applies only to to the intermediate cylinder of the triple-expansion engine; the valves of the high and the low-pressure cylinders are plain slides, and are moved from the intermediate, the motion for the high-pressure cylinder being reduced by means of the lever, as shown in the engraving on page 1.

The water end of this pump is 24″x24″; it is provided with large and free water passages, and the arrangement is such that the whole inside can be examined in a few minutes.

This engine was built to handle four millon gallons of water in 24 hours; but we are informed by the engineer in charge that it runs noiselessly at a speed of 100 strokes per minute, at which speed it will deliver between six and seven million gallons. It is, as will be seen, as simple as an ordinary small steam pump, and just about as easily handled.



CUT ILLUSTRATING VALVE MOTION OF THE DAVIDSON PUMPING ENGINE.

What Determines the Selling Price of Goods in a Competitive Business?

Writers on economic subjects have various ideas upon the subject of the selling price; thus, some say it depends on cost of production, others that it is determined by the law of supply and demand, and considerable confusion results in the mind of the student. The fact is, that the selling price of an article depends upon so many different conditions, that no general law can be laid down. The following may be given as an approximate solution:

The selling price depends upon the condition of the trade. When there is a "boom," prices tend to rise to the limit of "what the market will bear"; that is, to the highest figure that consumers will pay rather than go without, or rather postpone purchases. Copper rose in a few months, from 10 to 18 cents a pound, and then purchasers stopped buying, and a panic resulted, which forced prices down.

When there is a depression in trade, prices tend towards a minimum limit, which is the cost at the most favored mill, or the one which can produce the cheapest, and in cases when there is an overstock they may even go below cost for a short time; producers making a sacrifice to meet notes falling due, or to prevent the greater loss due to letting a factory remain idle, and to the dispersion of skilled workmen.

In times of normal trade, neither "boom" nor "depression," what fixes the selling price is most admirably stated by Mr. T. J. Borden, of Fall River, Mass., thus:

"The selling price of goods is not fixed by the cost of production in the establishment which can produce them most economically, but rather by the cost in a concern that can just sustain itself without making either profit or loss. Human nature is such that all who can do better than this cheerfully pocket the profit, and those who cannot do as well go to the wall, leaving the selling price to be determined by those at the foot of the class, rather than by those at the head." K.

The Envelope System of Filing.

BY PROF. A. T. WOODS.

I wish to endorse the statements on methods of filing, made in the article entitled "A Scrap-book Substitute," in the AMERICAN MACHINIST of Feb. 13. I have been through the usual round of systems of filing, scrap-book, index-rerum, note-books, card catalogues and envelopes, and have no hesitation in saying that if any one will give the last a fair trial, he will find it by far the most satisfactory. This method, in the shape which the writer has found satisfactory, with minor changes, is due I believe to Professor Chandler, of the Columbia College School of Mines, who has used it for many years on an extensive scale.

Perhaps the best way of calling attention to the special features of the system will be to describe it as in use. The envelopes are of smooth (calendered) manila paper, so that dust will not stick to them, 7¼ x 9½″, and open on the side, backs cut high, flaps not gummed. The filing case consists of a set of pigeon-holes 2″ high, 7⅜″ wide and 9½″ deep. The title of the contents of each envelope is written on the lower left-hand corner of the face of the envelope, as shown in the accompanying sketch (page 3) by "Valves." The envelopes are placed in the filing case alphabetically, beginning at the upper left-hand pigeon-hole, so that the title of each is readily found, without withdrawing them. On the face of each, the sub-titles of articles, pamphlets, etc., which are contained in it, are written, as shown by the parallel lines on the sketch, so that each envelope practically carries its own index.

When the envelope on a subject becomes filled, file a second one on the same subject, or subdivide it. For instance, take the subject of *valves;* if its importance to the user demands it, file as *valves, globe; valves, pump; valves, gate; valves, steam stop*, etc., giving each sub-subject one or more envelopes, as required. Then, when one pigeon-hole becomes crowded, move the envelopes up or down, and so re-distribute them. The advantage of the perfect flexibility of the system is apparent. There is no limit to it, and no confusion arises from its extension. If one envelope is not enough for a subject, make two or three; if one pigeon-hole is crowded, move into the next, as no labels are necessary; if the case becomes filled, have a second one built.

The case is a cheaply made affair. The sides and upright partitions are pieces of inch board, or ⅞, 9½″ wide, having saw cuts about ⅛″ deep, 2″ apart. The horizontal partitions between pigeon-holes are pieces of picture backing slipped into the saw cuts. Strips of moulding over the front edges of the uprights cover the saw cuts, and top and bottom boards, and a back of picture backing complete the case.

A filing case of this sort will hold almost everything that one is apt to want. Pamphlets, papers read before the engineering societies, and small catalogues will generally go in with ease, although the writer is inclined to think that it would be better for his purpose if the envelopes had been made ½″ longer and wider. Articles from technical and other papers are cut out, folded and filed in the appropriate envelopes, generally without any pasting. To make the system perfect, one should have two copies of those papers which he finds of most value to him, to provide for the possibility of having articles on different subjects on the two sides of a sheet; but generally it will answer very well to file the clipping under the head which is most apt to be referred to, and to make a "cross-reference" on a pad, stating in what envelope this second subject is to be found, and filing the sheet on which the reference is made in the proper envelope. The writer has found this method satisfactory. References to books, bound volumes of society transactions, and drawings, are made in the same way. If the reference is to a library book, or one not in the possession of the filer, make an abstract on a pad, and file the sheet.

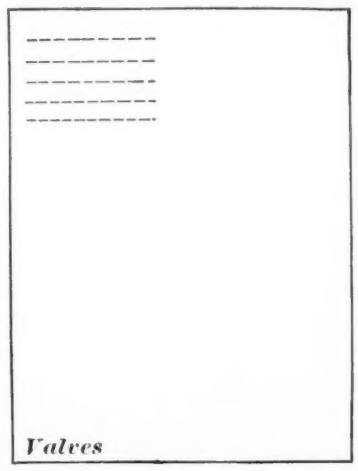
For notes when traveling, etc., cards about the size of postal cards take the place of a pocket note-book. Notes and sketches are made on a card or cards, and filed in the proper envelope when opportunity occurs, and are then where they can be found at a moment's notice when wanted. The same applies to calculations, rough sketches, etc. If made at home, the pad comes into use; if abroad, the cards; but in either case there is no transcribing of notes, and they are not hidden away in some note-book where an index is necessary in order to find them.

Now as to the advantages and disadvantages of this system and others. A card catalogue of information has the advantage

of taking little time to *file* your data, if it can be called filing, but when you want to look up a subject, the probability is that several bound volumes of technical papers are to be hauled out, some loose copies extracted from the pile of unbound ones, and several note-books brought to light; then, with a desk full of extraneous material, you are ready to dig for the data in question. With the envelope system, the time has been used at the other end of the line, *i. e.*, when the filing was done. When the information is wanted, two or three envelopes, and a book or two, possibly, are gotten together, and the data is all at hand in a moment, including perhaps a paper read by somebody before one of the engineering societies, several years ago, articles from several papers of recent and old dates, calculations made on a similar question which you have forgotten, a note on something seen at H. & Co.'s shops, and a letter or two bearing on the subject. All are there together, and having refreshed your memory therewith, you are prepared to be a walking cyclopedia on that subject, for the time.

It does take time and work to get such a system in working order; but the writer is confident that it pays to do the work, and that if any one tries the envelope system he will not regret it, and will not abandon it. The work of cutting up papers, etc, can be done at odd times, and the services of an assistant or some member of your family may be utilized for cutting out marked articles, etc.

There are, of course, some people who object decidedly to cutting up their papers, and such will have little use for the envelope system. But it is to be supposed that a man subscribes for a technical paper for the use which he can make of it in his business. It is of more use, to some of us at least, when cut up and filed for ready reference, than when in bulky bound volumes. It is said that one is apt to throw away something which he may afterwards need. Doubtless that is true, and we all do it at times, in one way or another. But if an article or item is not considered worth filing, it would not be thought worth cataloguing, and if that is not done, an item in some paper, which is in the midst of the bound volumes of three or four papers for ten years or so, is not far from being practically thrown away.



ENVELOPE SYSTEM OF FILING.—See Page 2.

Taper and Irregular Turning Box Tool.

The cut presented herewith represents a taper and irregular turning box tool recently brought out by the Jones & Lamson Machine Co., of Springfield, Vermont.

This tool is designed for a turret screw machine, or turret lathe, and occupies but one hole in the turret, like any other turret tool. It is for the accurate turning of taper pins and bolts of all kinds, and irregular shapes, like handles, etc.

This tool was primarily designed for turning the taper bolts used in locomotive shops, where it has met with great success, but it is fitted for taper and irregular turning of all kinds, and is made in all sizes, adapted to the entire lines of screw machines and turret lathes made by the company.

The sliding template shown in front is a plain bar of steel, with its under side of the exact taper required. The point of the screw beneath bears on a shoe, which in turn bears on the template. This screw passes through an arm of the rocking tool carrier. The pin at the head end of the sliding template is to be held by a projection on the carriage. The carriage is readily set in the proper position, so that, when the power feed of the turret is thrown in, for either direction, the tool advances or recedes, while the template remains stationary. The point of the cutting tool is thus swung out or in, and the exact taper or form of the template given to the piece turned.

A taper can be cut in either direction up to the full milling length of the machine, and it will cut from or up to a shoulder.

This is wholly unlike the ordinary taper attachment of an engine lathe. On a lathe the taper which is cut is double that to which the taper bar is set, so any error made in setting is doubled in turning.

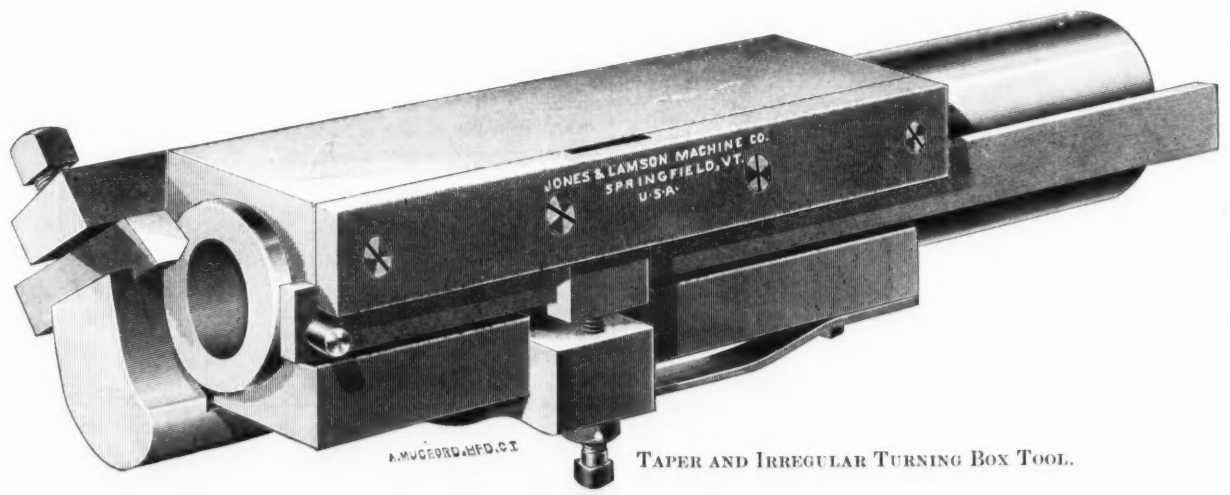
With this tool the taper of the piece turned will be the exact taper of the template, and the template, being a detachable part, can be made as accurate as the class of work to be done may require.

The accuracy of the taper work done by it compares very favorably with that done on the lathe, while, of course, the rate at which work can be turned out by it is much faster.

Any number of templates of different tapers or forms can be readily made, and all that is needed to change the taper is to replace the template with another, which can be done in an instant.

After a template is once made no further measurements or adjustments are necessary for that taper, so that the advantages of the system will be at once apparent to any one who has had experience in producing taper work in large quantities.

Among the other places where these tools have been introduced are the new shops of the Pennsylvania Railroad at Altoona, where a number of them are to be used in making the various standard taper bolts used on their locomotives.



TAPER AND IRREGULAR TURNING BOX TOOL.

A London dispatch says:

A meeting of the General Steam Navigation Company was held to-day. The report of the company showed that the recent strike of laborers had cost it a sum equal to the amount required to pay a dividend of 10 per cent. The cost of labor had increased 35 per cent. The report further said that, if the strike was renewed, the bulk of the shipping trade would be diverted to other places.

Well, if the bulk of the trade does go elsewhere than London, it will be to places where the laborers—the men who do the work that keeps such companies alive—can make a more decent living. It would not be the first failure to hold business in places which, if put in competition with other places more favorably situated, living wages could not be paid. There is no evidence that any one outside the companies believe that the wages received by these laborers is any too great. If they can do as well in London as in other places on less wages than they are now getting, they will be sure to stay there, even at a reduction. If the conditions are such that the London companies cannot afford to pay them living wages, then these companies ought to stop business and let the men go where they can live. Men do not raise potatoes in New York City—they would cost too much. Possibly it costs too much to do the work of these companies in London. If the companies have lost the equivalent of a dividend of 10 per cent. through increasing the wages of the laborers, they must have had a pretty good time of it before the increase, or must be rapidly treading the road towards bankruptcy now.

Literary Notes.

THERMODYNAMICS, HEAT MOTORS, AND REFRIGERATING MACHINES. By De Volson Wood, C. E., M. A., Professor of Engineering in Stevens Institute of Technology.

This work has been prepared to meet a want experienced by the author in his course of instruction in Thermodynamics. His aim has not been to bring down the subject to the comprehension of the reader, but to lead him up, by a more easy and uniformly graded path, to the same height, and at the same time familiarize him with the way by a free use of illustrations, exercises, historic references and numerical examples. Special attention is called to some of the graphical representation of internal work, supposed to be new, as well as many of the exercises and the discussion of Entropy, or the Thermodynamic Function.

The first chapter is devoted to fundamental principles and general equations; and the remaining chapters treat on perfect gases, imperfect gases, heat engines, refrigeration and combustion. Although this work is intended principally for students in technical schools, it contains much matter of a practical nature relating to simple and compound steam engines, air compressors, injectors and refrigerating machines, stated very plainly, and therefore the work recommends itself to practical men. The exercises are excellent, and will aid the student in comprehending the subjects treated.

Any one who has a fair knowledge of calculus, and studies the work from the beginning, will undoubtedly be well repaid. The book is published by John Wiley & Sons, New York. Price $4.

SPONS' ENGINEERS' DIARY AND REFERENCE BOOK FOR ENGINEERS, MACHINISTS, CONTRACTORS, AND USERS OF STEAM. For 1890.

This Diary contains tables and such information as engineers and contractors have frequent occasion to refer to. It has a good index, so that any portion of its contents can be readily found. It not only contains a calendar for 1890, but also for 1891 and '92. There are many blank pages, properly dated, for the engineer's notes and memoranda. The Diary is published by E. & F. N. Spon, 12 Cortlandt street, New York. Price $1.

We have received from Mr. John M. Goodwin, C. E., of Sharpsville, Pa., a pamphlet entitled, "Power Towing on Canals and Rivers." The primary object of the pamphlet is to set forth the advantages claimed for Mr. Goodwin's system of driven-cable towing, which, while we do not understand that it has been given a trial of such a nature as to positively demonstrate its practicability seems to have no features upon which a prediction of its failure in practice could be founded. It involves, among other things, a continuously moving endless cable, to which tow lines are attached or detached by a new method, admitting of the gradual starting of the boat without undue strain or the slacking of the cable, which is to be driven by stationary power plants. The arrangement is such that towing by horses or the navigation of the canal by steam-driven vessels, as at present, are not interfered with.

The claims made for the system by its author seem to be moderate and reasonable, and incidentally the pamphlet contains much that is of interest regarding the various plans that have been proposed for supplanting horse-power for towing.

Some system of power towing which shall be cheaper than the one at present in general use, and which at the same time will increase the capacity of boats and of the canals by the improvement in speed, would certainly be of great benefit, and will, when devised, meet with a favorable reception. Whether Mr. Goodwin's plan will effect this or not, cannot be positively known, of course, until a section of some canal has been equipped with it, and tested. But we should say, from an inspection of the drawings and specifications, that there would be a good chance of its success.

We have received from Mr. John T. Rich, Commissioner of Railroads for the State of Michigan, his annual report for 1889, together with the reports of the various railroads of the State made to the Commissioner for the year 1888.

The Commissioner says that the casualties in coupling cars continue to increase, there having been an increase of thirteen for the year 1889. While the outlook for automatic couplers is not considered very favorable, that for power brakes on freight trains is thought to be encouraging, and that the time is not far distant when all trains will be controlled by some form of power brakes. Not much progress is reported in the matter of safety heating for passenger cars, though various devices, some of them possessing considerable merit, have been tried. "Stoves and frail heaters have been ordered out of cars forming part of passenger trains."

No employes were killed during 1888 in collisions, and only two were injured, but 10 were killed and 144 injured in coupling cars.

The report on interlocking switches is very favorable, and forty of them were put in during the past season. They are credited with saving time, making travel safer, and are meeting with general favor at the hands of railroad managers.

Mr. W. S. Rogers, who for some time past has held the position of Chief Draftsman and Mechanical Engineer at Watervliet Arsenal, West Troy, N. Y., has resigned his position, and about the 15th of this month will take the position of superintendent of the shops of the F. W. Richardson estate at Troy, where the Richardson's balanced valves, etc., are made. Too much "go ahead," about Rogers for a permanent berth under the government, but he was there long enough to gain some experience, and to design some machinery which is unlike any ever before used on gun work.

A Substitute for Quarter-twist Belts.

It sometimes happens that it becomes necessary to connect by belt two shafts which cross each other at right angles, one above the other, and the most common method of doing this is by the use of quarter-twist belts. Where the shafts are separated from each other a considerable distance, as compared with the width of the belt and diameter of pulleys which must be used, such a plan works tolerably well; but still it is better, as most mechanics fully understand, to avoid the use of such belts wherever possible. This is especially the case where the shafts are separated by a small distance only, and considerable power is to be transmitted, because these conditions require a wide belt or large pulleys, and sometimes both, which, when the distance between the shafts is short, makes the side pull upon the belt excessive, and destructive to belt, as well as wasteful of power.

We receive a good many inquiries from our readers regarding the least possible distance between shafts that a quarter-twist belt of given width can be run over pulleys of a given size, and though it is quite generally understood that such belts are regarded only in the light of necessary evils, that would be avoided if possible, we are convinced that the method of avoiding them, which we here illustrate, is not so generally known as it should be, or it would be more frequently met with. We cannot say to whom the credit of originating it belongs, and we have seen but one example of its use, which was at the Niles Tool Works.

The arrangement is shown in the sketch, in which S is the lower shaft from which the upper shaft s is driven, the speed of the latter being in this case twice that of S, though it is apparent that the pulleys on the respective shafts can be of any desired proportion to each other, so long as both pulleys on the same shaft are of the same diameter, and are placed at a distance from each other, "center to center," equal to the diameter of the pulleys on the other shaft.

The pulley D is the driver in this case, d being the driven pulley, the other two pulleys being loose on the shafts and provided with long bearings and collars to keep them in proper position.

The long bearing is made more important in this case by the fact that the respective shafts and their loose pulleys revolve in opposite directions, making the relative speed of the rubbing surfaces twice what it would be in the case of an ordinary loose pulley at the same belt speed. The shaft can in this case revolve in either direction equally well, which is not the case with quarter-twist belts, and there is no distortion or sidewise straining of the belt. Another advantage where this is used in close quarters is that the belt is about twice as long as by the ordinary driving. There is probably some increase of friction, though not necessarily very much.

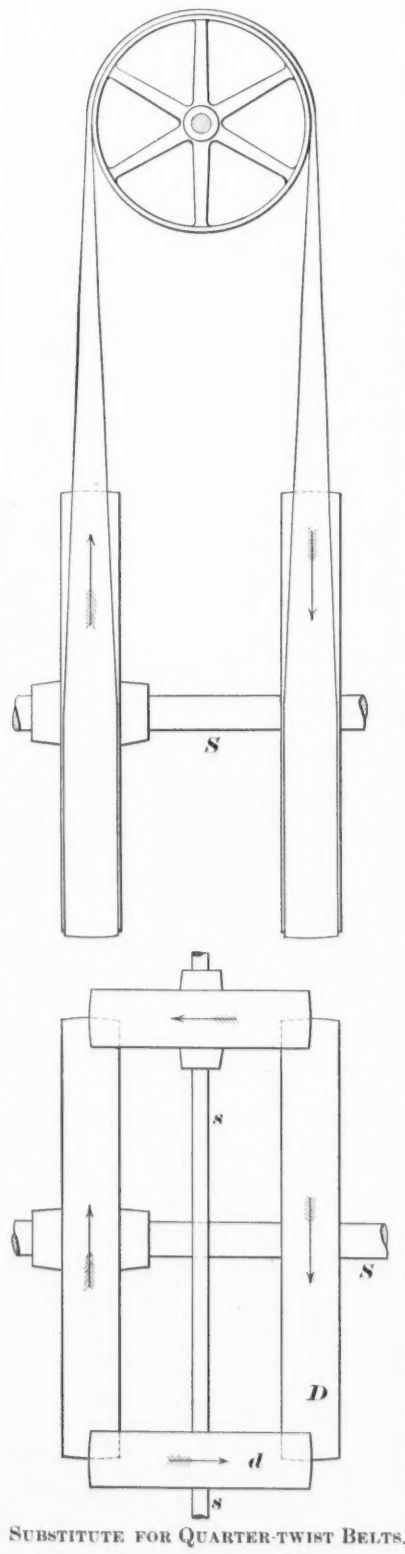
It is preferable to arrange as in the cut, so that the belt will pass directly from the driven pulley to the driver, as, if it passes over the loose pulleys while under the strain due to the work, the loss of friction will be much increased.

This latter condition would obtain if the relative positions of the pulleys in the cut remained the same, but the direction of motion were reversed.

There is no doubt but there are many situations where quarter-twist belts are in use, that it would pay to replace them by such an arrangement as this.

Somebody of an ingenious turn of mind gives us the metric system, "not in a nutshell," but in a nickel. It is claimed that our nickel five-cent piece holds the key to the linear measures and weights. The diameter of this coin is two centimeters, and its weight is five grammes.

Five of them placed in a row will, of course, give the length of the decimeter, and two of them will weigh a decagramme. As the kioliter is a cubic meter, the key to the measures of length, it is also the key to the measures of capacity. Any person, therefore, who is fortunate enough to own a five-cent nickel, may carry in his pocket the entire metric system of weights and measures.—*Cleveland Plaindealer.*



A SUBSTITUTE FOR QUARTER-TWIST BELTS.

The Maximum Density of Water.

BY W. H. BOOTH.

It appears a simple matter to find out at what temperature water attains its maximum density. The first natural idea is to fill a vessel with warm water, and note as it continues to fall in temperature how long it is possible to add more, and when the water begins to overflow.

To do this exactly calls for a narrow tube above the closed top of a vessel of a great bulk compared with that of the small tube, in order to magnify or rather concentrate any expansion or dilatation which may take place.

Such an experiment is by no means really so simple as it appears; for, to secure accuracy, a knowledge is essential of the factor of expansion of the material containing the water. Such further additions to an experiment greatly impair its value and accuracy, and though an experimenter may show his knowledge of physics and skill as an observer by duly observing and allowing for all such corrections, yet that man is the better practical man who conducts an experiment which does not require to be corrected for external influences. As an example of such a perfect experiment we may describe that

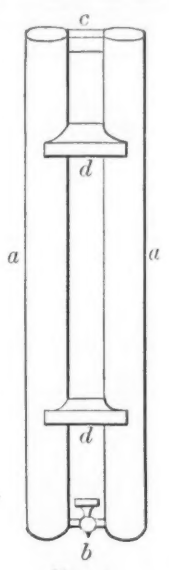


FIG. 1.

which was conducted by the late Dr. Joule for determining the temperature of maximum density of water.

Joule was led to make the experiment, in the belief that as a standard, water at 60° Fahr., was unsuited, as its variation in volume for small differences of temperature was too rapid at and about 60°, whilst at or near maximum density its variation is slow.

He therefore determined to ascertain what was the real point of maximum density, and devised as his one instrument, apart from accurate thermometers, that shown in Fig. 1, which is drawn to a scale of $\frac{1}{2}'' = 1$ foot.

This instrument was simply a pair of thin tinned plate cylinders 54 inches high by 6 inches diameter, secured together by two pieces of wood d, d, and connected by a well-ground plug tap b at their lower ends, and by a trough c at top ends, about one inch square in cross-section, and fitted with a cut-off sliding door at its middle. The whole instrument was swathed in hay, to prevent radiation, and it was supported like a billiard table, in pillars which passed freely through the floor, on which the operators stood, so as to free the instrument from vibration.

Joule argued that if the two cylinders were filled to the upper trough, and therefore to the same level, with water at two different temperatures, then if the lower stop-cock be opened there would be a flow of water from one to the other, water passing from the cylinder containing the heavier liquid.

Joule used thermometers sufficiently delicate to register to within $\frac{1}{100}$th of a degree Fahrenheit. He determined their freezing points afresh a few hours before making his experiments. To equalize the temperature of all the liquid in each cylinder, he used a stirrer, which was simply a 4-inch tin disk on a slender rod of iron, and before each test of temperature the stirrer was used.

Assuming that an experiment was to be made, and knowing roughly that the maximum density of water was near 39° Fahr., then if water at 36° was placed in one vessel, and water at 41° in the other, there would be a flow through the stop-cock when opened into the one vessel, and a flow into the other vessel by way of the upper trough. It was necessary to determine this flow. This was done by means of a hollow glass ball about three-eighths inch diameter, so adjusted as to barely float. In this way was overcome the tendency to adhere to the trough sides, which would have been caused had the ball floated high enough to cause capillarity. All water used was distilled in tinned vessels, and kept quiet, so as to avoid impregnation of air. The experiments were thus made:

Both vessels were filled with water at 37°. Hot water was then added to one vessel until its temperature rose to 41°.5. Thermometers fixed to suitable stands were arranged to dip six inches below the surface of the water in each vessel.

The slide and stop-cock were then both closed, and each vessel well stirred and the temperature noted.

The slide and cock were opened, an interval of three minutes was allowed to elapse, and the glass ball was put into the trough and its motion noted for two or three minutes by a graduated rule on the trough top.

The slide and cock being then closed, the water was stirred and temperatures again read.

The accepted temperature of observation was taken as the mean of the temperatures before and after the experiment.

A series of such observations followed one another, and as the laboratory temperature was 38°, only the hotter vessel cooled faster than the cooler vessel heated, and after two or three hours the flow was found to be reversed in direction, proving that while at first the warmer water was lightest, at the last the cooler water had the least gravity.

The annexed table gives the data and results of the first series:

SERIES 1.

Temp. of Warm Vessel.	Temp. of Cool Vessel.	Mean of Two Vessels.	Current in Trough. Inches Per Hour.
41°.183	37°.348	39°.265	280 from warm vessel.
41 .129	37 .368	39°.248	240 " " "
40 .959	37 .363	39°.161	20 " " "
40 .905	37 .368	39°.136	8 " " "
40 .711	37 .317	39°.014	40 " cool vessel.

At first the flow was very rapid, and indicated a considerable difference. The third test showed a remarkably small flow, the fourth only eight inches and the fifth a reverse flow. To use Joule's own words, "We could hardly have anticipated more satisfactory results than those of the above table. They show clearly that while water at a temperature of 40°.905 is lighter than water at a temperature of 37°.368, water at 40°.711 is heavier than water at 37°.317; in other words, that 39°.136 is above, whilst 39°.014 is below the maximum point.

"By drawing a curve from the results we find the exact point of maximum density indicated by the above series of observations is 39°.102."

A second series was carried out in a warmer laboratory (41° temp.) which occasioned a gradual rise in each vessel.

The following results were got:

SERIES 2.

Temp. of Warm Vessel.	Temp. of Cool Vessel.	Mean of Two Vessels.	Current in Trough. Inches Per Hour.
40°.742	37°.368	39°.055	22 from cooler vessel.
40°.758	37°.420	39°.089	8 " warmer "
40°.773	37°.470	39°.121	60 " " "

This series indicates 39°.078 as maximum point, a third series showed it as 39°.134, and having thus satisfied himself that the actual point was very near to 39°.1, a severer test was next applied. The two vessels were arranged to have a temperature only $1\frac{1}{2}$ degrees different from each other.

The vessels were left in repose for six minutes before introducing the ball, and its motion was watched for four or five minutes, and the following are results:

SERIES 3.

Temp. of Warm Vessel.	Temp. of Cool Vessel.	Mean of Two Vessels.	Current in Trough. Inches per hour.
39°.921	38°.382	39°.151	30 from warmer vessel
39°.864	38°.398	39° 131	0
39°.821	38°.362	39°.091	0 "
39°.782	38°.332	39°.057	$2\frac{1}{2}$ from cooler vessel

The drafted curve showed 39.091 to be the maximum point.

The mean of the four series 39.102
39.078
39.134
39.091

Mean 39.101

which Joule considered to be within $\frac{1}{100}$th of a degree of the actual truth, and "it certainly cannot be more than $\frac{1}{20}$th of a degree in error." He believed any degree of exactitude would be arrived at by multiplying the series and averaging.

He seemed to consider as one of the most valuable results of his determination the power to determine the expansion of volume of glass bulbs which he would fill with pure water, reduce successively to two temperatures equally above and below the maximum point, and by observing the rise of liquid in

the stern at the lower temperature have a measure of the contraction of the bulb. Joule's own account of these joint experiments of himself and Dr. Playfair is to be found in the Memoirs of the Chemical Society, vol. iii.

Two-spindle Drill.

We illustrate herewith a two-spindle drill, adapted for light, sensitive and rapid drilling, or for such other manufacturing operations as are usually performed upon a multiple spindle press, this machine having the advantage that the motion and rate of speed of each spindle is entirely independent of the other, so that the ratio of speeds of the two spindles may be changed to suit the character of the work. This is found of great advantage when, as often happens, it is desired to drill a very small hole, and at the same time, or without removing the work from the gig or fixture, counterbore or face off a surface with a cutter of comparatively large diameter, or where two drills of greatly different diameters are used. Each spindle has three changes of speed independent of the other. Holes up to ½" diameter, and to the center of a 12" circle, can be drilled, the distance from the surface of the column to the centers of the spindles being 6½".

In depth it will drill, without readjustment of the table, 4", that being the amount of motion of the spindles. Work up to 30" in height is admitted between the table and spindles, the greatest distance here being 36".

The spindles are counterbalanced by a spring, the tension upon which can be adjusted to suit the weight of tools used, making them very sensitive, and the table is also counterbalanced for convenience, and to avoid danger of falling when being adjusted.

The spindles are provided with stops for drilling or counterboring to fixed depths, and all necessary features are provided for rendering the machine convenient and efficient.

The drills are made as illustrated, or with 3, 4 or 6 spindles, by W. P. Norton, Bristol, Conn.

A New Elevating Tool Rest.

We give on this page some illustrations of an elevating tool rest for lathes, designed by Mr. C. E. Pollard, the foreman of the machine shop at the Stiles & Parker Press Works, Middletown, Conn.

The block which fits the cross-slide to which it is attached by the usual gibs, is extended upwards, this extension being cylindrical in form and having a T-slot cut through it from front to back, the slot being inclined as shown by the dotted lines. In this T is fitted a sliding block, which has a tapped hole passing through its center, by means of which it is forced forward or back by the milled head screw shown. As this block or nut is moved either way by the screw, it also moves up or down, owing to the inclination of the slot in which it rests and as the outer piece in which the tool post is fixed rests upon the nut, it is moved up or down with it, thus giving a vertical adjustment to the tool. A good fit is secured between the two main parts of the rest, and the upper one is split at one side and provided with a binding screw by which it can be made firm.

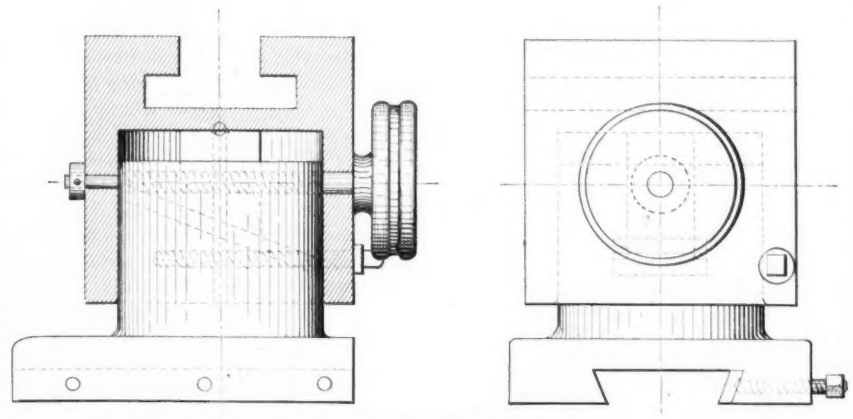
Of course we need not descant upon the advantages of an adjustable rest, as they are already fully appreciated, the problem being to get one which, while it shall be handy and quick to adjust, shall be firm and rigid. These qualities this rest seems to possess, and we understand that in use it has proven to be very satisfactory. It has been patented by Mr. Pollard.

American Society of Mechanical Engineers.

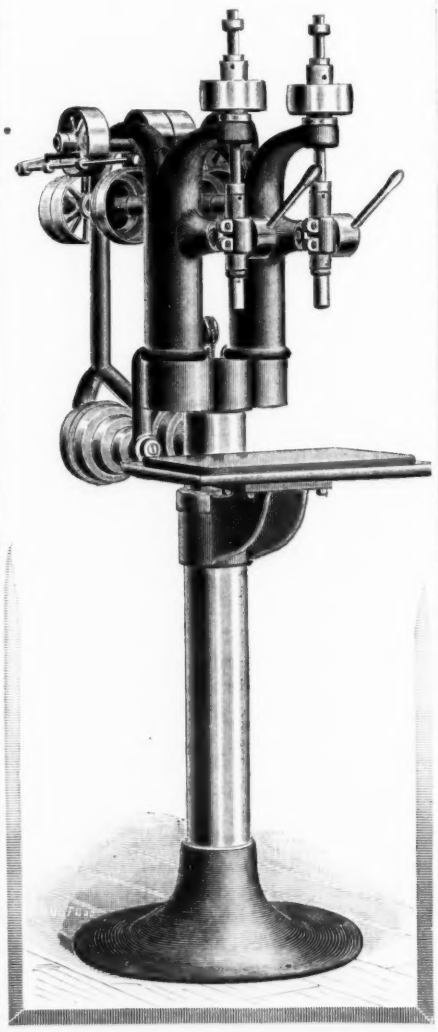
Secretary Hutton gives the following notice:

"The twenty-first Convention of the Society will be held in the City of Cincinnati, Ohio, beginning Tuesday, May 13th, in the evening. This date occurs in the week preceding the musical festival in that city, and is so chosen that any so desiring may enjoy both reunions for one journey. The papers for the Cincinnati meeting should be in the Secretary's hands before March 20th, and intending contributors are requested to send him the titles of their papers at once. Send also queries for the Topical Discussions immediately."

The people in Ellsworth, Me., have lost some of their money, but they know more than they did a year or so ago. They are enterprising, and when they saw such a rush and rage in all the towns near and far, from Passamaquoddy Bay to the Pacific Ocean, to have shoe factories, they raised $25,000 and built one. The addition to their population of large numbers of thrifty operatives, to be enriched, and to enrich others by a new and prosperous industry, was a dazzling prospect. They were doing well before with their shipping, their lumber, their fishing and their agriculture, but for that very reason they were pleased at the prospect of having opened to them another source of wealth. So they planked down the cash, erected the factory, equipped it with machinery, and effected an arrangement with an experienced firm in Massachusetts to occupy it. But alas! the tenants, after six months' trial, discovered that there was no room for more shoe factories, and they have given up the experiment. We have no idea that the experience of our friends in Ellsworth will serve as a warning to the inhabitants of other places that it is a mistake to build any more shoe factories. They will have to find that out, as the Ellsworthians did, by an actual trial. Still, it is none the less an obligation of kindness to point out to them that there are already abundant facilities for producing in this country forty per cent. more shoes annually than can possibly be consumed, and that some of the factories will have to be abandoned.—*Shoe and Leather Reporter.*



ELEVATING TOOL REST.



TWO-SPINDLE DRILL.

The American Patent System.

BY D. WALTER BROWN, PH. D.

VII.

PROCEEDINGS AT THE PATENT OFFICE.

Having, in the preceding articles, set forth the salient features of our patent system, it seems well to close the series by a brief statement of the practice before the patent office.

The first step in applying for a patent is the preparation of the "petition," which is a brief request directed to the Commissioner of Patents that a patent may be granted to the petitioner for the invention described in the specification which is annexed to the petition.

An inventor may conduct his case in person before the patent office, or he may appoint an attorney (solicitor) to conduct it for him, and the latter is the only safe course. The preparation of the claims and the proceedings at the patent office are too highly technical to be safely undertaken by any but specialists. An inventor who to-day attempts to prepare and manage his own case is likely to prove a very costly attorney in his own cause.

Where a solicitor is employed he must be authorized to act by a written "power of attorney," which is filed at the patent office. Usually the "power of attorney" is included in the "petition."

In addition to the petition and the power of attorney, the other written documents required are the "specification" and the "oath." Each of the foregoing documents must be signed by the inventor if he is living; if not, they may be signed by his executor or administrator, and the specification also requires two witnesses.

The specification, including the claims, has been hitherto discussed. It needs only to be added that they should be clearly written or printed, and must be in the English language.

The oath is an affidavit, in which the inventor solemnly swears before a notary or other proper officer that he is the original and first inventor of the thing set forth in his specification and claims; that he does not know and does not believe that thing was known prior to his invention of it; that it has not been patented to him or to others in any country;* and has not been in public use or on sale in the United States for more than two years before his application for a patent.

The oath is, of course, in writing, and is signed by the inventor; annexed to it is the "jurat," or certificate of the notary that the oath was sworn before him on a certain day.

In many cases the inventor assigns his invention, and the patents which may be granted therefor, to some other party. In such case the patent will issue to the assignee, if the inventor so request in writing. This request is usually incorporated into the petition, or it may be made afterward; but, in order that the patent shall issue to the assignee, the assignment must be recorded at the patent office.

Generally, the assignee should have the assignment recorded at the patent office as soon after it is executed as possible, in order to protect himself from surreptitious sale by the inventor to a third party.

For three months after its date, an unrecorded assignment will protect the assignee's right against subsequent parties who in good faith buy the same patent. After three months it will not protect him. The safe and proper course is to have the assignment recorded as soon as made.

In every case where the device can be shown by a drawing, a drawing is required. As many sheets of drawings may be used as are needed to contain all the views of the invention which it is desirable to give. The manner of executing these drawings is very particularly prescribed by the rules of the patent office, and these rules must be exactly followed.

Each sheet must be 15"x10", and there must be a margin line all around the sheet one inch from the edge, leaving the space within the lines 8"x13". The ink must be jet black. Smooth bristol board must be used, and the shading should not be too fine, and should be sparingly employed. The reference letters should be of good size—from an eighth to say a quarter of an inch high.

Patent drawing is a work by itself. The great need is clearness—clearness, that is, in illustrating the method of operation, and the essentials of construction. As a rule, the fewer the lines, and the simpler the execution of the drawing which will do this, the better. The elaborateness of construction drawings for engineering purposes is not desirable; would, in fact, be injurious to a patent drawing. In all cases, therefore, the drawings should be made by a special patent draftsman under the direction of the patent solicitor. The latter's supervision of the arrangement of the several views, with the purpose of best showing and emphasizing the salient features of the invention is of great importance. The drawing (and each sheet) must be signed by the inventor or his attorney, and be witnessed by two witnesses.

The petition and power of attorney, and the specification and oath, should all be attached together, so that each may be identified at the patent office by the others, rolled with the drawings into a neat roll, and sent by mail or express to the Commissioner of Patents. At the same time a letter should be addressed to him referring to the application, and enclosing the first fee of $15. In order to get the application on the files of the patent office it is necessary that the petition, specification, oath, drawings, and the first government fee shall all have been received there. The proper course is to send them all to the office at the same time.

Models are now but seldom required, and should not be sent to the patent office until the inventor is notified that a model is necessary. When such notice is given, the model must be furnished, or the case will not be considered any further.

When the invention is a composition of matter the Commissioner of Patents will usually require the inventor to furnish specimens of the composition and of its ingredients for experiment by the office, and also a sample of the composition for preservation.

After the application has been received at the patent office, begins its examination and the proceedings prior to the allowance of the patent. Generally these proceedings take the form of notifications to the inventor that one or more of the claims as originally filed are anticipated by prior patents which are cited. To meet such objections, or any others, the specification and claims may be amended until they are satisfactory to the Examiner at the patent office, or until he finally rejects the application. In this latter case, the inventor can appeal to the Board of Examiners

*If foreign patents have been granted in any countries, the oath contains a list of those countries, and a statement that the invention has not been patented in any countries except those.

in Chief, who will review the case and give a decision for or against the application. If the board also decide against the inventor, he can appeal to the Commissioner of Patents, and from his decision the inventor may appeal to the Supreme Court of the District of Columbia. In case of an adverse decision by the Commissioner of Patents or by the Supreme Court of the District of Columbia, the inventor may have his invention passed upon in the United States Circuit Courts.

For the making of the amendments to the specification and claims, above spoken of, the power of attorney gives the necessary authority to the solicitor, without requiring the signature of the inventor to such amendments.

The government fees are as follows:

When the papers are filed, $15.

After the inventor receives notice that his patent is allowed, and before it issues, $20.

This fee of $20 must be paid within six months of the date of the notice of allowance, or the patent will be considered forfeited, and will be withheld.

On applying for a reissue, $30.

There is no additional fee when the reissue is granted.

On appealing from the Examiner to the Board of Examiners in Chief, $10.

On appealing from the board to the Commissioner of Patents, $20.

When an appeal is taken to the Supreme Court of the District of Columbia, the applicant is required to pay to the Clerk of the Court a docket fee of $10.

LETTERS FROM PRACTICAL MEN.

The Fly-wheel Let Go.

Editor American Machinist:

On the 14th day of January, the 30-ton fly-wheel in the mill where I work "let go," doing considerable damage, but no one was killed. This fly-wheel was on the engine that drives a train of rolls. The cause of the "let go" was the roller let his tongs go through the finishing rolls; this broke the pillow-block bolts, and threw the fly-wheel on a twist. There were ten segments to the wheel, an arm to each segment, held together by two flanges on the shaft.

A new wheel was made. In the first effort to put a flange on the shaft it was heated by building a fire underneath it. It cracked through the holes. A new flange was made, and heated by standing it up and applying a gas flame at each side. This flange cracked also. As I am a young man, anxious to learn, I would like to ask some of the older readers of the American Machinist how they would heat such flanges. The enclosed sketch will give an idea of the flange that is heated.

The rim is 12x14 inches, 28 feet diameter. How fast would it be safe to run the wheel?

Lee O. Morris.

[The sketch referred to represents a flange 6 feet diameter, 3 inches thick, with a hub projecting 5½ inches on one side, and a collar projecting 2 inches on the other side. The flange is bored 24 inches, leaving 5½ inches of metal in the hub around the eye. There are 30 bolt holes in the flange, for 1¼-inch bolts.]

Piston Rod Packing—Damper Regulators.

Editor American Machinist:

The scheme worked on piston rod packing, as given by Duplex in your paper of February 13, 1890, is a good one, and, while it may be new to some of the craft, it is nevertheless old in this part of the country, especially among railroad engineers. I have known them, in the absence of a better quality of rubber, to use old discarded rubber hose, and fill in between it and the rod with hemp packing, claiming that manner of packing to be far superior to hemp alone. I know by experience that a good quality of rubber and asbestos applied as Duplex says is far superior to asbestos alone, and I will add that this same packing can be made to do nearly double the work, and at the same time do the same work with more ease and much better satisfaction by rigging an oil-cup to feed good cylinder oil upon the rod close to the gland. Say, for a three-inch rod, one drop of oil to about every 200 feet of piston travel, and to other rods in proportion to size. This manner of oiling piston rods will work equally as well on other packing—metallic packing not excepted.

By the way, there are engineers of to-day that appreciate the fact that hemp and tallow has seen its best days in the far past. However, there are some steam users yet in existance that will furnish nothing but the old-style hemp, simply because it costs less per pound than a kind and quality of packing that would be cheaper in the long run.

Speaking of hemp and tallow to pack piston rods reminds me of my advent as one of the craft. The first engine that I ever had charge of—thirty years ago—was at that time an old engine, the piston of which had to be packed with hemp. Talk about a soft snap—well, yes, we all appreciate the improvements as they come. Many of the young men of the profession to-day will stare with open-eyed wonderment at an old-timer relating past experiences.

Ash-pit doors can be automatically regulated as well as dampers, and both have their advantages and disadvantages. Follow the example of Tom Bolin in search of a wife: He met with a man that was the father of two good-looking marriageable daughters, and, being unable to decide which one to choose, concluded to take one for beauty and the other for kin. "I will take them both," says Tom Bolin.

The great disadvantage of a closed damper is the deposit of soot, and the great disadvantage of a closed ash-pit door is the in-rush of cold air when the furnace door is opened.

If it were left for me to decide this dispute between Duplex and Jonson, the damper regulator would be attached to the ash-pit door, and the damper arranged so that when the furnace door was pulled open the damper would be pulled shut. Is there any objection to taking them both?

S. A. Smith.

Belting.

Editor American Machinist:

I read with interest the articles on leather belting in the American Machinist. I would like to see and hear from more of your readers on the subject, as there is a wide difference of opinion in regard to which side of the belt to run on pulley face. My experience is that the hair side always gives the best results, and I also think that the belt will last longer, run with the hair side to the pulley. My experience is with small belts, mostly from 2″ up to 8″.

I had a discussion a few days ago in regard to the matter with a machinist. He claimed that a belt would last longer if run with the hair side from the pulley; he says that the hair side is the strongest, and that, if that be worn away, that the life of the belt is injured. That is all true enough; but will not the belt be injured more, if run flesh side to pulley, and in less time? My experience is that, if the flesh side be run to pulley, that the hair side loses its strength, and cracks. I would like to hear from others on this subject.

J. E. J.

Neither Priming nor Foaming.

Editor American Machinist:

In regard to Question No. 22, of January 16, I think, with F. W., that priming could not have caused the bubbling in water glass, nor do I believe that it was caused by foaming, as he says. I have had the same thing happen with me with two different boilers, and in each case I located the trouble.

The first was about seven years ago, with a new boiler, on a steamboat belonging to the Eagle Pencil Co. The water glass was in center of boiler, over fire box door. Everything was standing still, steam gauge registered 70 pounds, damper in smoke-stack closed, when I noticed a violent bubbling in water glass, running up as high as the top of glass. At first I did not know what to think. Every one said that the boiler was foaming. I noticed that the fire was coming out of furnace door in contact with the lower fitting of water glass, and came to the conclusion then and there that that was the trouble.

It occurred several times that day, but only when the damper in stack was closed and the flames touched the lower fitting, as before. The next day I removed the glass to one side of the boiler, and that ended the trouble.

The other case, about four years later, was with a stationary return tubular boiler with cast-iron front. The water glass was connected with ½″ pipe running between boiler and front. Sometimes, when the tubes were choked, which necessitated heavy firing, we had the trouble as in the other case. Thinking that the boiler was foaming or priming, I did everything I knew of to stop the foaming—blew down, pumped up, stopped the engine, etc., but all did no good. After being troubled some time I covered the ½″ pipe with asbestos and clay, and a piece of 2″ pipe over that all, to keep off the heat. This stopped the foaming or priming.

So I was satisfied that in each case there was no foaming or priming, but the heat coming in contact with connection to glass caused the trouble.

Therefore I think that B. B. will find something of the kind the matter in his case. If not, I am wrong.

At any rate I agree with the American Machinist that something is wrong and should be remedied at once.

Bernard Baratte.

Packing Piston Rods—Dampers—A Query.

Editor American Machinist:

In regard to Duplex's mode of packing piston rods, I agree with him fully, as I have used the same method, and have seen others use it for many years.

In regard to the damper argument with Jonson, I most emphatically take sides with Duplex, especially if it is necessary to close dampers with a hot fire. In such a case it is best to close ash-pit doors as the closing of a tight damper will hold too great a heat under the boiler—no doors that I have ever seen in forty years' experience closing so tight as to prevent the escaping of gases in the furnace. I have always provided a "bleeder" to relieve boiler in such an emergency.

I have a little pet on my hands that I wish to submit to the American Machinist. I have a set of duplex compound pumping engines; pump plungers 9″ bore, 12″ stroke, solid brass plungers. The pump rod, steel, 2″ diameter, working through ordinary stuffing-boxes. The flange of stuffing-box gland is 6½″ diameter, ¾″ thick and takes ½″ packing. The gland is held in place by two ¾″ bolts in the ordinary manner. Now for the point. I have caught this gland springing *outward* when plunger was going into water cylinder, and when the rod started to move outward, and consequently under the water pressure, it would straighten back to its place. I am pumping against 85 lbs. pressure. On the inward stroke of rod, when that end of cylinder is in connection with the suction, and consequently less than no pressure on the gland, it will spring between the bolts over a thirty-second of an inch. The springing is so great that it perceptibly springs the ends of the bolts apart. I have had to do this with ordinary square rubber packing (½″) end, and I have had to do it so much with soft Italian hemp, well picked, that I dare not run it until I have remedied it. Will the readers of the American Machinist please give their views, and a remedy?

Will "Duplex" please send his address to Box 231, Silver City, N. M. M. C. L.

Pressure of Air in Cylinder.

Editor American Machinist:

"Pneumatics," in Question 84, seems to be laboring under a very common and wrong impression in regard to pressures, and I take this opportunity of setting him straight. Suppose, first, we take a cylinder *open at one end*, and insert therein an air-tight piston. Of course this cylinder is filled with air at 15 lbs. per square inch, absolute pressure; so that both faces of the piston are subjected to a pressure of 15 lbs., and the pressure sustained by piston = 0. Now, when the piston is moved half way into the cylinder, the pressure within rises to 30 lbs., and the piston sustains a pressure of 30 — 15 (the outside atmosphere pressure); that is 15 lbs. If we now move the piston to the point ¼, the pressure rises to 60 lbs., and the pressure sustained is 60 — 15 = 45. Moving the piston to point ⅛, raises the pressure to 120, and the pressure sustained to 120 — 15 or 105 lbs.

If both ends of the cylinder are closed, so that the movement of the piston into the cylinder would produce a vacuum behind the piston—the pressures sustained by the piston at the points ½, ¼ and ⅛, would be respectively, 30, 60 and 120 lbs.

Of course this never actually happens, as compression produces heat, and this heat increases the pressure. "John Doe."

Internally and Externally Fired Boilers.

By D. W. Robb.

Several very interesting articles relating to steam boilers have appeared in your columns, but no reference has been made, that I am aware of, to the comparative efficiency of boilers having brick furnaces and those having internal furnaces, or "fire-box boilers." My attention was called particularly to this subject while visiting Europe last summer, by the almost universal use, especially in England, of internally fired boilers of the Galloway, Cornish, Locomotive and other types; while in America the externally fired "return tubular," and "water-tube" boilers are almost universally used for stationary purposes. I was again directed to this subject by a very interesting paper on "The Economical Generation of Steam," presented by Mr. Geo. H. Babcock, and read before the National Electric Light Association. Mr. Babcock very properly refers to the expense of maintaining flat-stayed surfaces, and the cost of keeping up the ordinary tubular boiler, and makes a very satisfactory showing of the cost of maintaining properly constructed water-tube boilers; but no reference was made to the cost of keeping up the furnace and brick-work of this and other externally fired boilers. It would interest the writer, and I have no doubt would be of general interest to your readers, if some reliable information could be given as to the cost of keeping the furnaces and setting of any of the various forms of externally fired boilers in proper condition to give good combustion of fuel, and proportionate evaporation of water, compared with the expense of keeping the furnaces of internally fired boilers in similar condition.

It is pretty well understood by engineers, that almost any of the standard forms of boiler, when constructed with proper proportions of heating surface, grate area, and tube opening, to suit the fuel used, and adequate provisions made for circulation of water and escape of steam from the water, will evaporate about an equal amount of water per pound of fuel.

It is claimed in some quarters that a brick furnace will induce better combustion than one with water walls; but while it is reasonable to suppose that the heat absorbed by the bricks will tend to give steadiness to combustion, and possibly give more perfect combustion, if the fuel is added irregularly, or in large quantities, I think it will be conceded by those who are acquainted with reliable tests, showing the very high evaporation attained by the "Galloway," and other forms of internally fired boilers, that these two classes of furnaces stand about on a par in efficiency.

Although the brick furnace may compensate to some extent for poor firing, it will lose through external radiation, and after all *the best guarantee of good combustion is a hot fire, evenly spread over the grates*, and of such thickness that only sufficient air will be admitted to support combustion; this cannot be accomplished in any furnace by poor or irregular firing.

The common return tubular boiler without doubt represents in boiler construction about the minimum of first cost, and, when

properly proportioned and set, will give as high evaporation as any other form.

The steam users of the United States may be congratulated upon having in this matter, as well as in many other mechanical devices, adopted the most simple, and at the same time very effective apparatus for the purpose intended. But there are other things to be taken into account in estimating the practical efficiency of a boiler besides its first cost and its ability to stand a good evaporative test when first set up. These points may be briefly classed as follows: First. Will the boiler continue to evaporate as much water per pound of coal after it has been in use for a continued period, unless frequent repairs are made? Second. If not, what will these repairs cost per horse-power per annum, and how will a brick furnace compare, in this respect, with one surrounded by water?

The writer is acquainted with instances of externally fired boilers, which, after continued use, did not evaporate much more than half the water per pound of coal that they did when new. This might in some measure be accounted for by the condition of the heating surfaces, but a close examination indicated that it was mainly due to the condition of the brickwork, air being admitted in many places besides under the grate. It may be claimed that this state of things should not be allowed to exist, but is it possible, taking into consideration the frequent expansion and contraction of the boiler proper, and the independent expansion and contraction of the brickwork, to prevent the admission of enough air to seriously hinder combustion in the furnace, and to cool the gases after combustion has taken place? Frequent inspection and repairs under competent direction might prevent it, but what will such inspection and repairs cost, especially to a small consumer, to whom the loss means as much increase of production as to the larger operator?

In considering the cost of maintaining internally fired boilers, this form of furnace may be depended upon to admit air only where and when it is required, and to continue to do so as long as the boiler lasts; but there are other matters which may add to the cost of maintaining the furnace in a state of safety and efficiency. In the locomotive form of boiler the first cost of the furnace is very great, and the cost of proper inspection and maintenance of the flat plates and extensive system of stays is also very considerable, rendering this form of boiler almost impracticable for stationary purposes, especially in large sizes. But there are other forms of internal fire-box, notably the "Fox corrugated furnace," "Adamson flanged furnace," and the "Galloway furnace," which require no staying, and, in the moderate duty required of land boilers, are easily kept up. Most of the boilers having these furnaces are constructed with a small amount of heating surface in proportion to size and weight, consequently the first cost is greater per horse-power than the return tubular, and their usually great length of flues requires a more powerful draught than the boilers commonly used in America; but there are modifications of these types, and combinations of the tubular fire-box with the multi-tubular form, which have all the advantages of both without excessive first cost.

Undoubtedly there are other considerations beside the form of furnace which may affect the commercial value of a boiler; chiefly the condition of the heating surfaces, and safety under high pressures, and continued use; and I think these matters might be discussed with advantage through your valuable columns.

The condition of heating surfaces in regard to deposits of sediment or scale depends, apart from the quality of water used, largely upon the freedom or rapidity of circulation of the water, and the provision made for the deposit of such sediment below the heating surface. These matters may be provided for, to a greater or less extent, in any of the standard forms of boiler; but those having internal fire-boxes generally possess the advantage of having the lowest point below the reach of the fire, and, if the fire-box is round and without stays, will have good circulation, and tend to keep the surfaces immediately above the fire clean, while the opposite is the case in externally fired return tubular boilers, having concave surfaces to catch sediment, directly above the fire. The matter of safety is, to some extent, provided for, giving steam users a choice between a well-constructed water tube boiler and any other form under steam boiler insurance and inspection. No doubt a more rigid government inspection would be an advantage, and would lead to improvement as to quality of material, machine flanging, punching to template and reaming rivet holes or drilling in place, which would not add very greatly to cost, if systematically introduced in process of manufacture.

Would not a system by which boilers could be tested for evaporation and fuel consumption regularly, and guarantees given, be acceptable to steam users, upon something like the same plan as boiler insurance, possibly carried out under the same management, but requiring inspectors capable of making correct tests of evaporation, and thoroughly versed in the requirements for good efficiency?

The guaranteed could check the fuel consumption, with little trouble and quite close approximation, by weighing the fuel, and using a water meter. It might be necessary to have certified firemen also; but this all boilers should have. I hope some of your many talented readers and correspondents may be induced to give their views and experience on this important subject.

New Horizontal Spindle Milling Machine.

The machine shown in the illustration is of the double upright and crosshead class. It is designed for long and heavy milling, sometimes called "slabbing," also for such work as guide bars, connecting rods, milling of boxes, etc. It can also be used for key-seating shafting or axles as large as 10″ in diameter.

The base or bed of the machine is of the box class, reaching to the floor, which insures stability and firmness from vibration. It is a heavy casting, well stiffened by girts, and insures a solid support for uprights and table.

The table is 14″ wide, and is made 6 or 8 feet long, as required. It has three T-slots running the entire length of the top; each end has a pan cast on, and there is also a groove or trough running entirely around the edge for collecting oil or other lubricants used on cutters, and conveying it to a trough on the back of the bed, and thence to a receptable in the base of the machine, accessible by door shown in front.

The table is moved by cut rack and gearing, and is so geared as to be easily moved by hand.

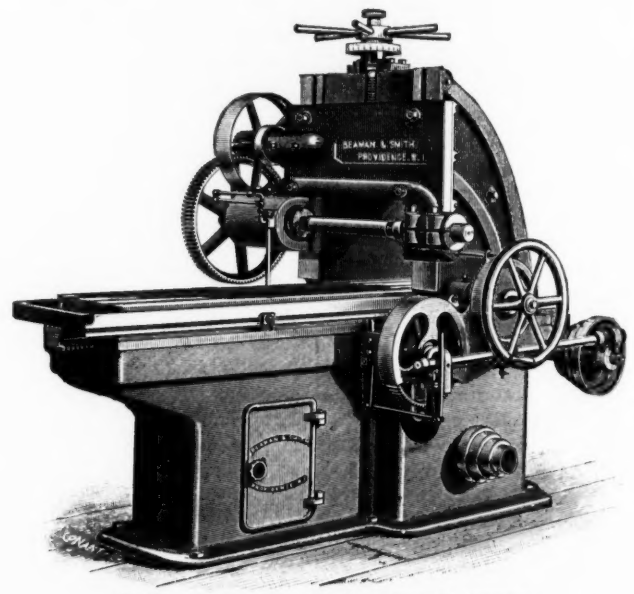
The crosshead is gibbed to uprights, and is adjusted by a screw with pilot wheel in center of housings, and is provided with a movable graduated dial, reading to $\frac{1}{1000}$, which facilitates accurate measurement for sinking cuts or adjustment. The distance between the uprights is 19 inches.

The spindle runs in bronze bearings $4\frac{3}{8}$″ diameter and $5\frac{1}{2}$″ long, and is driven by a $3\frac{1}{2}$″ belt over a 16″ pulley, through gearing in the ratio of 5 to 1, arranged for four speeds. Provision is made for horizontal adjustment of cutters, in addition to that afforded by washers. The greatest distance from top of table to center of spindle is 14″; the least, 3″. Cutters to $8\frac{1}{2}$″ can be used. The cutter section of spindle is $1\frac{1}{4}$″ diameter, 14″ long. It will be noticed the outer end of spindle is supported.

The feed is driven from the spindle, which is a very important consideration on all machines using belting to transmit the power, as it is very necessary that the feed should stop when the spindle does, whether from design or accident. The feed is actuated by means of a worm and gear driven by cones having four sections, can be thrown out by hand as desired, or stopped automatically by adjustable stop, and is the full length of table.

A pump driven from the countershaft at a constant velocity returns the oil or other lubricant from the tank to cutter. A relief valve allows the lubricant to go direct into the tank from the pump when the outlet to cutter is shut off.

The countershaft has tight and loose pulleys 14″ diameter for 4½″ belt; the builders are Beaman & Smith, Providence, R. I.



HORIZONTAL SPINDLE MILLING MACHINE.

The Human Body Improved.

We have all heard a great deal from time to time regarding the perfect adaptability of the human body to the various uses for which it is intended, and we have been taught to believe that, considered simply as a machine for accomplishing certain things, it was well nigh ideal perfection, and left no room for improvement. It is evident that this is not believed by a certain Russian inventor, however, for he has recently taken out patents in this country for what should, according to the custom of the patent office, be called, "Improvements in the Human Body, Designed to Facilitate Walking, Running and Jumping." It is, however, simply called an apparatus for the above mentioned purpose. The drawings show two large springs in the shape of a bow, their upper extremities attached to the shoulders or at either side of the waist, and the lower extremities to the victim's feet. The necessary bands and buckles and harness for securing the springs are disposed about the body in such a way as to convey the impression that the culprit had undertaken to whip an editor, and had to be bound together until the healing process was completed. We don't know how it works, but we imagine that, whatever the inventor may claim as to the improvement in efficiency, he will scarcely have the assurance to claim improvement in architectural features.

A new process of tempering steel has been invented by Captain Feodossieff, of the imperial Russian Navy. Captain Feodossieff is inspector of metals used in naval construction at the Imperial Arsenal. Glycerine is the substance employed, and it is used as the bath for hardening, tempering and annealing steel. The specific gravity of the glycerine is varied from 1.08 to 1.26 at 15° Centigrade (59° Fahr.), by the addition of water, according to the nature of the steel, and the effect desired. The quantity of glycerine used is one to six times the weight of the pieces to be plunged into it, and its temperature varies with the hardness of the metal from 15° to 200° Centigrade (59° to 392° Fahr.), the higher temperature being employed in the case of the harder steel, whilst the lower temperature is used for tempering the milder steels. Additions of various salts to the glycerine are recommended to increase its quenching powers. For a hard temper one to 34 per cent. of manganous sulphate may be added, or one-quarter to 4 per cent. of the potassium sulphate; for a softer temper, one to 10 per cent. of manganese chloride, and one to 4 per cent. of potassium chloride may be used. We cannot say how valuable this process may be. It has been patented in Russia and England, but we are not informed whether or not it has been patented here. It seems to be attracting considerable attention among our English contemporaries.

A well-known Boston engineer sends us the annexed clipping from the *Boston Herald*:

A Boston inventor has recently patented a method of generating power from the tide, which has the promise of remote utility, at least. He uses the displacement of tide-water by means of a large float, held in position by cables, which, on the rising and falling tides, accumulates immense power. This method will give 16 working hours out of the 24. The power thus generated can be stored for use by means of storage batteries or compressed air. An eminent engineer estimates that in Boston harbor, where the tide rises nine to ten feet, a displacement of 15,000 cubic feet of water will give 1,140 horse-power for 24 hours, which is confirmed by estimates of other experts. The plant for generating such power, he claims, will not cost as much as a similar steam plant for doing the same work, and, when once finished, the cost of producing this power will not exceed 10 per cent. of the cost of steam power. This, of course, may be regarded as extravagant; but if power from the tides can be realized at even 75 per cent. of the cost of steam power there are many places where it will come into use for mechanical and light purposes by means of the electric current.

He writes:

I am not "eminent" enough to figure more than four-tenths horse-power for twelve or less hours per day, or a fifth horse for a steady twenty-four hours per day, counting out friction. Deducting loss from friction and inefficiency of secondary motor, this storage system might keep a sewing machine at work.

A good deal of absurdity is being developed in regard to the unit by which power is measured—the horse-power. Some writers gravely argue that, as a horse cannot for any considerable time exercise power capable of raising 33,000 pounds one foot high in one minute of time, we have a false standard. What difference it makes, except to the owner of the horse, whether he can or cannot do this work, is one of the things that no one can find out. Horse-power is a unit that every one understands, and horses may work all sides of it without alarming consequences. Better let it rest.

Thomas D. West, well known to our readers as an author on foundry matters, is preparing a book especially designed for foundry apprentices. We have no doubt that Mr. West will write a book that will give apprentices exactly the information they ought to have.

Alexander I. Cotheal, Consul-General of Nicaragua in the United States, writes us to say that the address of the Nicaragua Canal Construction Company, about which inquiry was made last week, is 44 Wall street, New York City.

We should like to get the experience of foundrymen who have used aluminum in cast-iron.

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Engineers of the Navy.

The building of the new naval cruisers by private engineering firms is having one effect, which was probably almost entirely unlooked for, and which seems to bid fair to prove somewhat embarrassing to the Navy Department. Engineer officers are said to be resigning from the navy at a rate which threatens to seriously impair the efficiency of the corps. The cause of these resignations is in the fact that the shipbuilding firms which have contracted to build cruisers can afford to, and do, offer better compensation for the services of a competent engineer than the Government will pay, the natural result being that they get their men.

Chief Engineer Melville, in his recent annual report to the Secretary of the Navy, calls the attention of the department to this matter, and makes some recommendations designed to bring about a better state of affairs. He calls attention to the fact that the modern war vessel requires more engineers than the older types, because of the large increase in auxiliary machinery employed, and also because much of the principal machinery is separated in various water-tight compartments, each one requiring a competent engineer in charge at all times. Just at the time when an increased number of engineers is required, a decreased number is available.

Various excellent recommendations are made regarding courses of instruction and training for engineers, and the establishment of a school is advocated, in which a special course of instruction shall be given. New York is preferred as the location for this school, because there the students will have the best opportunities for visiting large engineering establishments where work is going on, and also for inspecting modern vessels.

At present there is a law confining appointments to graduates of the Naval Academy, and the repeal of this law is recommended, because it is believed that the great technical schools are turning out every year large numbers of young men specially trained in the elements of mechanical engineering, who only require experience at sea, and the course of post-graduate instruction, to make them valuable engineers in the navy.

Chief Engineer Melville has proven himself a competent officer, for whose opinions we have the greatest respect. He clearly sees the difficulties that stand in the way, and it is probable his recommendations if followed, would involve as much departure from present practice, as there is any hope of securing for years to come, if ever—a fact, which, of course, he fully understands, and which may have its weight in preventing him from making more radical recommendations.

But it will do no harm, we think, to call attention to the difference between the methods pursued by our own Government, as well as others that maintain navies, and the owners of ships which are run simply for getting the best and most practical results, and not with a view to providing good places for anybody.

We hardly think any one will claim that the engineer officers of our own or any other navy are superior, simply as managers of the machinery of vessels, to the engineers of the great transatlantic lines plying between this country and Europe.

If the engines and other machinery of any naval vessel, anywhere in the world, have given any better results in service, have worked with greater economy, or in a generally more satisfactory manner than those in the vessels of these great merchant lines, we have yet to hear of it. But the engineers on these vessels come up through the shops. They are almost invariably machinists, who, working in the shops in which such machinery is built, show sufficient ability and aptitude for the business to be trusted with the care of machinery at sea. Starting at the foot of the ladder, they work themselves up to the top, if they ever get there, solely by their own abilities, stimulated by the knowledge that promotion will depend almost entirely upon themselves.

Under the law, as it is now, a man who might have had charge of the engines of the "City of Paris," and proved himself in every way worthy of the utmost confidence, would be ineligible for the position of engineer of the meanest and smallest vessel of our navy. And even supposing he possessed the knowledge necessary to pass any examination that could be passed by any of the regular engineer officers, he would still be barred; the law requiring, not simply that he shall possess certain knowledge, but that he shall have acquired that knowledge in a certain manner, and at a certain school.

This is absurd. Chief Melville's recommendation that the law be repealed is a good one; but it should, we think, go still further, and recommend that any one who could show that he possessed the necessary knowledge of the business, such as is required in the merchant marine, for a position as assistant engineer, should be eligible, and should then be fully eligible for promotion, as experience and further study qualified him. Then the Government should pay as much, if not a little more than the same men could command elsewhere, and thus make it an object for the best men to remain in the service.

The report also brings out the fact, which is said to be well known to the engineer officers, that the very best mechanics (who hold the position of petty officers) rarely make more than one cruise in a naval vessel, because no privacy is given them, and no opportunity for keeping their clothing in decent shape, and it is recommended that this be remedied by providing them with separate quarters, "about like the present steerage."

It is scarcely cause for wonder, we think that "the very best mechanics" refuse to be treated as common sailors are treated in the navy, especially when they reflect that no amount of natural aptitude, nor of hard study and application, can ever give them the least basis of hope for promotion to more responsible positions.

The system was borrowed from countries where there are numbers of the younger sons of aristocrats that must be provided for at the expense of the government. It is out of place here, and the quicker it is revolutionized, the better.

Government Ownership of Railroads.

The annual report of the Chicago & Alton Railroad, which has recently been made public, contains a surprising proposition, and one which will no doubt give an alarming shock to many people. The president of the road, T. B. Blackstone, after reviewing and commenting upon past and prospective legislative interference with railroads and its effect upon shareholders, proposes that the government shall become the owner of all the railroads, and shall operate them in the interest of the public. He even goes to some extent into details, and gives his ideas of how the matter should be managed.

Of course this is not a new proposition, but it is, we believe, an entirely new thing to have such a thing proposed by a prominent railroad official.

Of course it is socialistic, and, when taken in connection with the recent utterances of the German Emperor, is well calculated to make us stop and ask, Whither are we drifting? We do not think, however, that it is necessary that any one should get frightened at mere names. Government control of railways is the rule in some other countries, and does not seem to disrupt them. It probably has some advantages over the present system, and it is just as certain that it has some disadvantages. Whether its advantages or its disadvantages would preponderate in our country we believe no one can say until it is tried. And there is one comfort about the matter, and that is that this or any other experiment can be tried in this country, and will be tried whenever a clear majority of the people make up their minds to try it, without the necessity or even serious danger of a revolution, without which such experiments would be impossible in most European countries.

We do not believe that the full socialistic scheme, in which all earnings of individuals would be pooled and divided without reference to individual ability or enterprise, will ever suit the American people; and perhaps one of the best safeguards against the adoption of any such scheme is the fact that a majority of them can at any time take a step in that direction and observe its effect, withdrawing if that effect seems to be evil.

In the American common school system we have an example of such a step which we have taken, which has met the approval of the people, and has been continued accordingly. In the municipal ownership of water works, gas, and electric lighting plants is another step in the same direction, which has met with the general approval of the communities in which it has been tried.

If government control of railroads is ever tried, and turns out as well, it will probably become permanent, but it will continue only so long as it has the approval of the people by reason of its working well.

Whatever steps have been or may be taken in that direction, there is, we think, little or no chance of the full socialistic programme being adopted, and we see no cause for any one getting very badly frightened at the outlook. There is a saving common sense in the American people, in which we have the fullest confidence.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(94) F. E. W., Greenfield, Mass., asks: Is the pressure on the bottom of a steam boiler greater than at the top? *A.*—Yes. See answer to Question 65, in our issue of February 13, current volume.

(95) Oil Stone, St. Louis, Mo., asks: What is Arkansas oil stone, and how did the name originate? *A.*—It is a smooth stone, suitable for sharpening edged instruments. It is found in Arkansas, hence its name.

(96) T. W., Baltimore, Md., asks: Where can I obtain nitrate of tin? *A.*—From any wholesale druggist. Nitrate of tin is obtained by adding potassa, or an alkaline carbonate, to a solution of perchloride of tin. This substance is also known as stannic acid.

(97) J. W., ———, asks: What is the size of the smallest drill used in a watch factory? *A.*—The American Watch Tool Co. state that "There is no hole in the watch requiring a drill smaller than .02 inch. . . . We understand that in watch factories, as a matter of curiosity, much smaller holes have been drilled."

(98) W. M., Dresden, Ont., writes: Give me the safe and best cutting speed of a 3 foot 5 inch grindstone. I think your last AMERICAN MACHINIST [Jan. 9] will wake up quite a few people on that subject. *A.*—We have been at some pains to ascertain the practice in this matter, and you will find the results published in our issue of March 6.

(99) J. A. F., Bridgeport, Conn., writes: We have been putting in a new steel boiler; it has been running about two months, and it has commenced to rust in the leg, about four inches from bottom of ogee. We are not using any condensed water, and do not understand why it should rust so soon at this particular place. What will be the best thing to stop it? *A.*—It is difficult for us to state the cause for the trouble without examining the boiler. But we suspect the water—have it analysed, which may show that a feed-water purifier or a change of water is necessary.

(100) Reader, Indianapolis, Ind., writes: I have a small engine, 2 inches bore by 3 inches stroke. Boiler is 42 inches high, 16 inches diameter, 10 flues, 2½ inches diameter and 20 inches long; fire-box, 13 inches high; receiving chamber, 9 inches high; thickness of steel, $\frac{5}{16}$ of an inch; boiler pressure to be carried, 65 pounds. How large a boat will this engine and boiler drive? Should it be a round or flat bottom boat? Please give size of propeller. *A.*—Length of boat over all, 18 feet; breadth outside, 4 feet 6 inches; depth, 2 feet. The boat should have round bottom. Propeller 12 inches diameter, 21 inches pitch.

(101) F. H. P., Haverhill, Mass., asks: 1. Will a boiler 24 inches diameter and 4 feet high be large enough to run a two horse-power engine? The boiler is to be a plain one, without any tubes, made of steel ⅛ inch thick. *A.*—If you mean an ordinary upright boiler with a cylindrical fire-box and chimney running from furnace crown sheet

through outer crown sheet, and properly riveted, it is large enough. We prefer to make the steel $\frac{7}{16}$ of an inch thick, as $\frac{1}{2}$ of an inch is too thin for calking. 2. About how heavy should a connecting rod be for a two horse-power engine? *A.*—That will depend on the design of engine.

(102) H. W. R., Waynesboro, Pa., writes: Please give me a simple rule for finding the tensile strength of boiler iron plates, and how to find the heating surface of a boiler. *A.*—The ultimate tensile strength of iron per square inch is given in any of the engineers' pocket books. Frequently the tensile strength per square inch is stamped on the sheet. Multiply the tensile strength per square inch by the thickness of the sheet; the product will be the ultimate tensile strength for every inch in width of the sheet. Divide this product by the factor of safety, generally 6; the quotient will be the safe stress allowable for every inch in width. For finding the heating surface of a boiler, simply add the number of square above the grate surface in the boiler to the number of square feet in the flues, and to any other surface which is in contact with the water on one side and exposed to heat on the other side; the sum will be the heating surface.

(103) P. F., Jersey City, N. J., asks: What is the centrifugal force per square inch of section of a conical pulley—the large diameter is 16 feet, running at a velocity of 200 feet per second; the small diameter is 13 feet 6 inches; width of face, 2½ feet; thickness, 1 inch? Also, what would be the speed to burst the cone? *A.*—The tension per square inch of section at the given speed will be 3,403 pounds per square inch. The highest speed will depend on the quality of the cast-iron; we would not like to risk it over 350 revolutions per minute. 2. I would like to know if the tension would be greater when the face of the pulley is on an angle than it would if parallel to its axis. *A.*—There will be a difference in the tension, but practically this difference can be neglected so long as the center gravity of the section remains at the same distance from the axis.

(104) G. V. H., Mexico, writes: Please explain the best plan to build a China pump. How high and how far apart should the flights be, and how many feet should the belt travel to do the best work per minute? Does this class of pumps work better at an angle than vertical? Should the flights be in a tight box? *A.*—This pump is a common irrigating device used in China, and is simply a chain pump. There are several forms of chain pumps. One form consists of an endless chain passing around a wheel above, and descending into the water below around a second wheel. In the upward course of the chain it passes through a vertical tube, whose lower end is submerged, and at whose upper end the water is discharged. Along the chain are round disks, which fit the bore of the tube, and form pistons which elevate the water as the chain ascends in the tube. The cellular pumps are of this kind, and, when packed pistons are used, they are termed *paternoster pumps*, from the resemblance of the chain and pistons to the rosary. Whether the chain is to be vertical or at an angle will depend on the purpose for which the pump is to be used. The speed of the chain should be about 160 feet per minute. You will find a number of small illustrations (not working drawings) of various pumps of this class in Knight's American Mechanical Dictionary.

(105) F. X. F., Oakland, California, asks: What will be the safe working pressure of a flue 95 inches long, 30 inches diameter at one end, and 14 inches diameter at the other end? The flue is made of steel $\frac{5}{16}$ of an inch thick at the large end, and $\frac{4}{16}$ of an inch thick at the small end. *A.*—A single-riveted flue of the above dimensions will safely carry a pressure of 63 pounds per square inch against collapsing. This pressure has been calculated by the formula given by United States Board of Supervising Inspectors of Steam Vessels, and is as follows: For cylindrical lap-welded and riveted flues in boilers, the flues not exceeding 8 feet in length,

$$P = \frac{89{,}600 \times T^2}{L \times D}.$$

In which T = thickness of flue in decimals of an inch, L = length of flue in feet, D = diameter of flue in inches, P = pressure of steam allowable in pounds per square inch. In the foregoing example we have taken

$$D = \frac{30 + 14}{2} = 22 \text{ inches},$$

which is the mean diameter, and T = mean thickness. 2. What thickness of steel is required to carry 150 pounds of pressure per square inch, the tube being of the same dimensions as before? *A.*—Mean thickness, $\frac{9}{16}$ of an inch.

(106) C. B. C., Conneaut, O., writes: We have a tubular brick-set boiler, 16 feet long by 60 inches diameter, with eighty 3-inch tubes, 25 square feet of grate surface. It is rated at 80 horse-power. By hard firing we have been able to evaporate 450 gallons of water from 60 degrees Fahrenheit per hour, using about 500 pounds of bituminous coal; steam at 65 pounds. How many horse-power is it developing? *A.*—Taking as one horse-power the evaporation of 34½ pounds of water per hour at and from 212 degrees Fahrenheit, the boiler is developing 129 horse-power. 2. Our stack is of brick, 63 feet high from grate, 24 inches square at base, 20 square at top (inside), draught gauge indicates .2 to .3 inches of water. There are no buildings around that are over 40 feet high. Is the stack large enough? *A.*—Yes. 3. Could we increase the capacity of the boiler by building a larger stack, say 90 inches or 33 inches square inside, and 75 feet high? *A.*—You can increase the capacity of the boiler by increasing the height of the chimney, but we believe that no advantage will be gained by increasing the cross-sectional area of the chimney at the bottom; it is now fully as large as the cross-sectional area of the flues; and, besides, you are doing good work with the boiler. If more steam is needed we should advise to add another boiler, and then build a chimney larger in cross-section and greater in height. 4. Would you advise building the stack with a straight flue, or should it be larger at the top than at the base? *A.*—Many engineers favor building the flue larger at the top than at the bottom; we should built a straight flue.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Graduating Machines. A. T. Koopman, Chicago.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Valve Seat Rotary Planing Machine. Pedrick & Ayer, Philadelphia, Pa.

Cylinder Boring and Facing Machines. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Whiton's Chucks. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Feb. 27, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

The Sure Grip Steel Tackle Blocks must fill the bill, according to the large sales reported. See advertisement, page 13.

Watch this column for our Weekly Announcement of Bargains. Selling Overstock. McFadden Co., 1,025 Market st., Philadelphia, Pa.

25" 28" 32" 36" Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

Patents.—Patent soliciting of high class. D. Walter Brown, 31 Nassau st., New York. Send for "A Brief History of Patent Legislation in the United States."

Inventors and everybody will get their work as ordered. Facilities devoted exclusively to accurate Designs, Drawings, Models, Light M'f'g. Difficulties a specialty. F. A. Gardner, 108 Liberty St., N. Y.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

Superintendents of industrial establishments will find the *Engineering and Building Record*, published weekly at 277 Pearl st., New York, useful. Municipal and building engineering problems a prominent feature. Specimen Copy, 10 cents.

The Lexington Gear Works, of Lexington, Mass., have issued a Catalogue of some six hundred sizes of Cut Iron Spur and Bevel Gear Wheels. Every machine or manufacturing concern in the country should send for a copy.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines.
T. C. Dill Machine Co., Philadelphia, Pa.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller. Propellers of same pattern and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices. Consulting Expert and Constructing Engineer. Estimates made on machinery and on damages.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES

The Bel Air (Md.) Water and Light Co. has been incorporated.

Cheney Brothers are building a large silk mill at South Manchester, Conn.

The Sumpter County (Ga.) Farmers' Alliance propose to build a bagging factory.

The Farrell Foundry and Machine Co., Ansonia, Conn., has increased its capital stock.

The Crescent Planing Mill Company has been formed at St. Louis, Mo. Capital stock, $50,000.

The Brownell & Wight Car Company, St. Louis, Mo., will build new and greatly enlarged works.

The Bethlehem (Pa.) Iron Co. has increased wages in all its departments ten to fifteen per cent.

The stock of the Buhl Stamping Company, Detroit, Mich., has been increased from $25,000 to $75,000.

The Lloyd-Booth Company, Youngstown, Ohio, are at work on an extensive addition to their foundry.

The Wayne Agricultural Works Company, of Goldsboro, will rebuild its foundry which was recently burned.

The Chattanooga Wooden Tray Company, Chattanooga, Tenn., has contracted for the material of which to build its works.

The Lockhart Iron and Steel Company has bought Long & Company's mill at Chartiers, Pa., and will soon start on merchant iron.

It is said that the Charleston, Cincinnati & Chicago Railroad Company will build extensive shops at Johnson City, Tenn.

It is proposed at Kingston, Ont., that the city offer a bonus of $200,000 to secure the location of the Grand Trunk railway shops.

The Newport News (Va.) shipyard is nearly ready to begin work. Henry Louitsky, formerly of Cramps', is superintendent of construction.

A "Citizens' Exchange" has been organized at Waco, Texas, for the purpose of making known its advantages to foreign capitalists and prospectors.

The Stiles & Parker Press Company, Middletown, Conn., have now on the floor, under construction, a toggle-joint drawing press, the weight of which is 65 tons.

A cotton manufacturing company has been organized at Waco, Texas. It has purchased the old cotton mills, and will engage in the manufacture of coarse fabrics.

The New Jersey Senate has passed Senator Pfeiffer's water bond bill, which allows Camden to issue bonds to the amount of $1,000,000 to extend the water privileges.

There is water-works agitation at Wapakoneta, Ohio; Union City, Tenn; Baxter Springs, Kan.; Franklin, Ind.; Cameron, Tex.; Coshocton, Ohio; Proviso, Ill.; Pottstown, Pa.

The Illinois Steel Company contemplate building a wire rod mill at Joliet, Ill. The company have expended about one million dollars during the past year in additions to its plant.

The town of Weare, N. H., has raised the sum of $25,000 to secure the removal of the Everett Knitting Works from Manchester to that town. The knitting company has a capital of $50,000.

The Brightman Machine Co., Cleveland, Ohio, has issued a new catalogue and price-list of shafting, couplings, hangers, planer and milling machine vises, and other specialties made at the works.

A proposition has been submitted to the city council of Dallas, Tex., to supply the water-works from the Trinity river. It is proposed to erect pumps and filtering apparatus with capacity for 3,000,000 gallons daily.

Jones & Mack, 110 West 5th street, Cincinnati, Ohio, write: We have established a new shop to take the place of the one burned out, and moved our office to the same place, and are now filling orders for the I X L drawing-board.

The Natchitoches (La.) Cane River Bridge Company has been organized, with David Pearson as president, to build the toll bridge over the Cane river at Natchitoches. It is to have two iron spans, 120 and 140 feet long, with a 75-foot draw.

The Mather Electric Co. will enlarge its factory at Manchester, Conn., to about double its present capacity. The new building will be erected across the end of the present structure, at right angles with it. It will be 250x60 feet, and three stories high.

The Betts Machine Co., Wilmington, Del., are making for the Midvale Steel Co. two lathes, the shears alone of each weighing 72,000 pounds, ratio of gearing, 250 to 1. The gears are cut steel. Each carriage carries two tools that will turn taper steel gun tubes.

The Miles Cutlery and Machine Works, of Kansas Ill., were incorporated on February 18, to manufacture cutlery and edged tools. The new corporation starts out with a working capital of $15,000. J. A. Paine, J. K. Boyer and C. M. Paxton are the incorporators.

Mr. Hiram Walker, of Walkerville, Ont., is president of the company recently formed for the erection of works for the manufacture of malleable iron at that place. The works that are now being erected will cover 420x390 feet, and will give employment to 300 hands.—*Canadian Manufacturer.*

The Water-waste Prevention Co., manufacturers of the Thomson water meter, 12 Temple court, New York, has issued a remarkably neat catalogue of these meters. This catalogue not only illustrates the construction of the water meter, but it does it in such a way as to give a good deal of information on the subject.

The Mason Regulator Company, Boston, Mass., are making good headway with their vacuum air-brake regulators. They are now furnishing these regulators to the Eames Vacuum Brake Co. More than a hundred of these regulators are in use by the Boston & Albany Railroad, and as many by the Fitchburg, and tests made on other roads have been very satisfactory.

The Mountain Spring Land Company, Chattanooga, Tenn., has been organized, with James Grange as president, J. Wesley Smith, vice-president, and C. E. Severance, secretary. It has purchased 1,000 acres of land on the Nashville, Chattanooga & St. Louis Railroad, and will lay off in lots and open streets. The company will, it is reported, construct a system of water-works.

There is a good deal of interest in Minnesota in regard to the development of the water-power at Fond du Lac, for the manufacture of wood pulp. Extensive transfers of real estate are being made, preparatory to the construction of dams and erection of mills. Jay Cooke, the president of the Duluth Water Power Company, and the Northern Pacific Railroad Company, are among the prime movers.

The St. Thomas Car Wheel Company, of St. Thomas, Ont., has been incorporated, with a capital stock of $250,000, to manufacture cast-iron and steel car wheels, iron and steel castings, to operate machine shops for the manufacture of all tools and equipments used in the operation of iron and steel foundries, and to operate foundries for the manufacture of iron, brass and composition castings, etc.

At a meeting of the citizens of Ware, Mass., it was decided to buy the plot of land opposite the Boston & Albany station at an expense of $40,000, and to erect buildings thereon suitable for electric light and steam power plants, iron foundry and machine shops. One of the machine shops is to cost $10,000, and, as soon as completed, will be occupied by J. F. Porter, of Hatfield, manufacturer of lathes.

The Cape Ann Drop Forge Works was recently incorporated, with the following officers: W. N. Fisher, president; N. H. Phillips, vice-president; Geo. R. Bradford, treasurer; and Geo. D. Loud, secretary and agent, with offices at Mason Building, Kilby street, Boston. The plant of the new enterprise is being erected at Gloucester, Mass., and will consist of a main building, 150x40 feet, and an annex, 48x50 feet. A side track of the Boston & Maine Railroad connects the buildings with the main line.

The Diebel Manufacturing Company, Philadelphia, Pa., has brought out a heavy grinder, which appears to possess a good deal of merit. It is massive, but neat in appearance, and the emery wheels are placed far enough apart to permit of two men working together. Rests adjustable in all directions are provided. The spindle, of steel, runs in self-oiling boxes which require filling only at long intervals. These boxes are so made as to distribute the oil evenly over the journals; they are protected by efficient dust shields.

Moses P. Johnson has just dispatched to Mexico a very large plant, consisting of engines, boilers, pulleys, shafting and belting, together with all the special machinery and special building materials complete, to be used in the extraction of the fiber of the plant from which "pulka," the most popular of Mexican drinks is made. This fiber is remarkably well adapted for manufacture into the form of cloth, bagging, ropes, or what not, and the machinery forwarded by the St. Louis house goes to a syndicate of London and New York parties, which will turn it to the best account in the directions indicated. It is claimed that, from a part of the fiber that has hitherto gone to waste, a cloth as fine and strong as silk can be made—so nearly like that article that it might easily pass for it. All the product of the syndicate's plan will go direct to Europe—most, if not all of it to Hamburg—where the finer and more recently discovered fiber will command fabulous prices.—*The Age of Steel* (St. Louis).

Machinists' Supplies and Iron.

NEW YORK, March 8, 1890.

Iron—American Pig.—The tendency of prices seems to be in buyers' favor, the same quiet feeling continuing to pervade the market. Only the standard brands sell at full quoted prices, the others being obtainable at concessions. We quote standard brands No. 1 X Foundry, $19.50 to $20; No. 2, $18.50 to $19. Grey Forge, $17 to $17.50. Some of the brands which are not so well known are selling still lower.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Situation wanted as foreman in a stove plate foundry; 20 years' exp. Refs. W. J., Concord, N. H.

Boiler maker foreman, 20 years' exp., is open for engagement. Address Boiler Maker, AM. MACHINIST.

Wanted—First-class foundry foreman. Address B. W. Payne & Sons, Elmira, N. Y.

Wanted—Position by a young mech. engineer. Refs. Tech. education, and some exp. Box 100, AM. MACH.

Mechanical draftsman and designer with pratical shop exp. wants position. Box 101, AM. MACHINIST.

Wanted—Several first-class machinists for lathe and vise work. Steady employment for good men. Pike Knitting Machine Co., Little Falls, N. Y.

Wanted—Situation as foreman in iron foundry making bench and light floor work. Good ref. Address C. S. F., 31 Madison ave., Detroit, Mich.

Wanted—A first-class machinist who has had experience in building paper machinery, to take charge of machine shop. Address Box 96, AM. MACHINIST.

Wanted—Machinists, boiler makers and moulders; good general workmen. Address Frick Co., Waynesboro, Franklin Co., Pa.

Wanted—Experienced man to take charge of gang of hands in erecting medium heavy machine tools. Address Machine Tools, AMERICAN MACHINIST.

Mechanical engineer wants permanent position as ass't sup't or chief draftsman. 10 years' exp.; technical education. Good refs. A. B., AM. MACHINIST.

Wanted—Assistant draftsman. A young man with some experience. Apply to the Stiles & Parker Press Co., Middletown, Conn.

Machinists Wanted—First-class vise and machine hands of good habits. Steady employment; good wages. John Featherstone's Sons, Chicago, Ill.

Situation wanted by an experienced pattern maker and draftsman. Can furnish good references. Address P. M. & D., AMERICAN MACHINIST.

Wanted—Mechanical draftsman who has had experience on high-speed automatic compound engine work. Give refs. Address L, care AM. MACHINIST.

Wanted—Foreman of machine shop in a well-known engine manufactory. Must be familiar with modern methods of economy. Address, with exp. and references, Box 97, AMERICAN MACHINIST.

Foreman pattern maker, 35 years' exp., is open for engagement. Best of references and recommendations. Accustomed to handling men. Brass foundry work preferred. M., AM. MACHINIST.

Machinists Wanted—First-class vise and machine hands of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, Ohio.

Thorough machinist and tool maker, exp'd as foreman in modern machine tool construction, open for engagement April 1. Skilled with micrometer. Address Box 99, AMERICAN MACHINIST.

Wanted—A good draftsman familiar with stationary engine work, to locate at our works in Tarrytown. State experience, and salary expected. Rand Drill Co., 23 Park Place, New York.

Position wanted by a 1st-class mech. draftsman. Good exp. in marine and all kinds of stationary engine work, designing of factories and sugar refineries. Ref. present position. B. S., AM. MACHINIST.

Position desired with reliable concern. Age, 24; married. Technical education. Represented Western house in N.Y. City. Exp. in locomotive and stationary tests, locomotive erection, gas engines, steam heating. References. 210 Vine street, Champaign, Ill.

Wanted—A position as foreman or sup't of machine shop, or as M. M. of R. R. shop. Has exp. in every dep't of marine and railroad work, and charge of men. A position in the West preferred. Will be at liberty after May 1. Only a permanent situation desired. Address E. H. P., AM. MACHINIST.

A mechanical engineer, now sup't of a large mfg. business, desires to make a change. Skilled in modern economical methods of manufacture, in machine and factory designing, and in estimate work; also experienced in steam plant erection and testing. Will be pleased to correspond with any party having a responsible position open requiring services of a competent, energetic man. A. S. M. E., AMERICAN MACHINIST.

MISCELLANEOUS WANTS

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d h'd Lathes & Drills. S. M. York, Clev'd, O.

Graduating Machines. A. T. Koopman, Chicago.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe, Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Higly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

For Sale—One heavy Hewes & Phillips Planer, 32"x32"x8 ft., in good order and repair. Address Capitol Mfg. Co., Chicago, Ill.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Inventions or improvements in measuring instruments & other fine tools wanted to manufacture & sell on royalty. "Tools," AMERICAN MACHINIST.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade

Wanted—Price and description of second-hand engines, pumps and boilers, in good order, by John Henry Blake, 182 Fulton st., New York.

Wanted—Second-hand engine lathe in good order, 24 in. x 12 ft. Write T. J. Sanford, 258 Broadway, New York, price and particulars.

For Sale—Cheap. 1-ton Yale hoist, and a heavy planer vise; also one 16-inch shaper. Address "Brooklyn," AMERICAN MACHINIST.

For Sale—Very cheap, one 39"x13', one 22"x12' screw cutting, and one 34"x18' lathe. J. & G. Rich, 120 N. 6th st., Philadelphia, Pa.

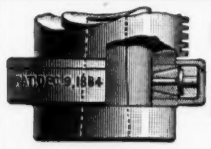
Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

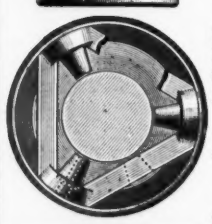
How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

For Sale—At reasonable price, lathe in first-class condition; 8 ft. swing, 20 ft. bed, gear on face plate, two tool posts, hollow spindle. Address Eagle Iron Works, 250 to 280 Woodbridge st., west cor. 5th, Detroit, Mich.

BRADLEY HAMMERS AND FORGES.
The BEST HAMMERS in the WORLD RUN BY BELT.
Over 1500 In Use.
Three Styles, 15 lb. to 500 lb. Heads.
Our FORGES heat irons fast enough to keep Hammers and men fully employed.
Send for Catalogue and Prices.
BRADLEY & COMPANY, Syracuse, N. Y.
63 Murray St., NEW YORK. 98 Sudbury St., BOSTON.

AN IMPORTANT PRACTICAL WORK
Railroad Engineers' Field-Book and Explorers' Guide.—Specially adapted to the use of Railroad Engineers on Location and Construction, and to the needs of the Explorer in making Exploratory Surveys. By H. C. Godwin. Morocco flaps, $2.50.
JOHN WILEY & SONS, 53 E. 10th Street,
(2 Doors West of Broadway, N. Y. City.)

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Bearings of all sizes made to order, and patent rights for sale by
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OUR NEW CATALOGUE OF TOOLS
And Supplies sent free to any address on receipt of Ten Cents in Stamps (for postage).
Chas. A. Strelinger & Co., WOOD AVE. Detroit, Mich.

"Star" Foot Lathe Swings 9x36 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers.
Catalogue Free of all our Machinery.
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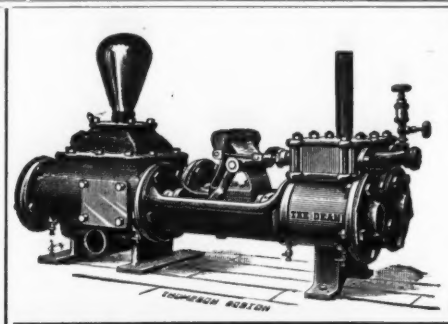
PATENTS procured. Trade-marks, &c., registered. Opinion & Court cases a specialty. Correspondence solicited. J. NOTA McGILL, Attorney-at-Law, Atlantic Bldg, Washington, D. C.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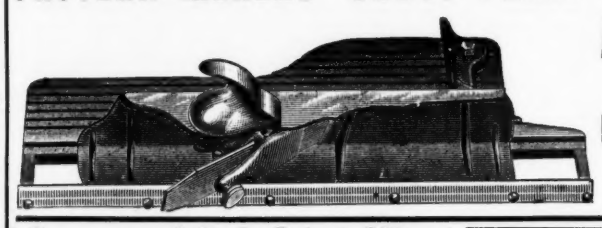
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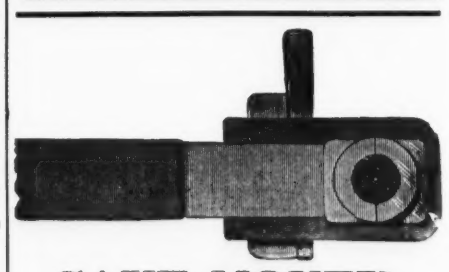
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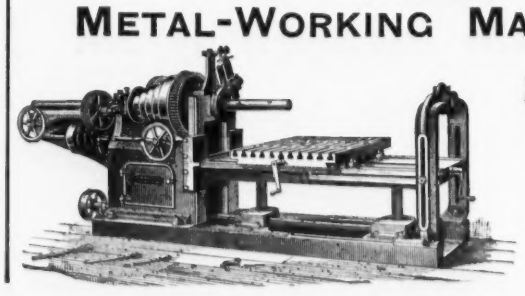

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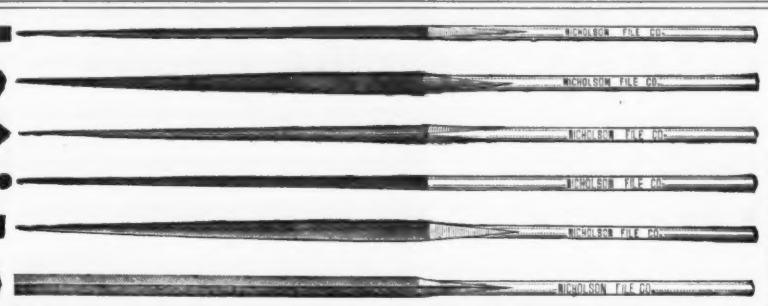

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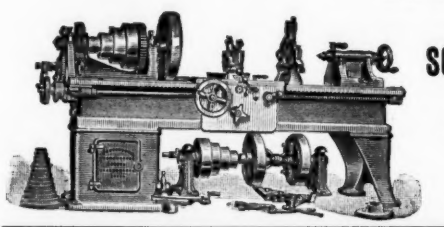

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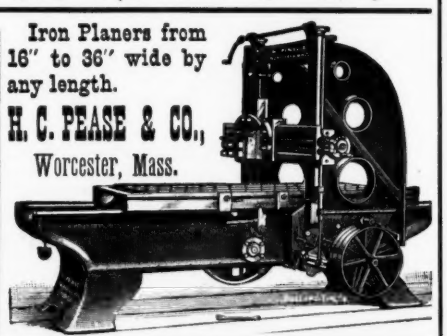

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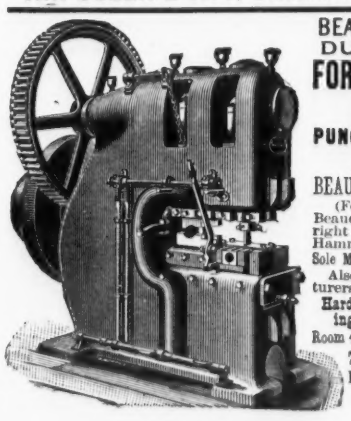

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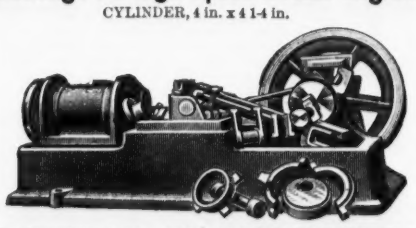

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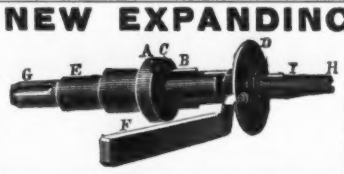

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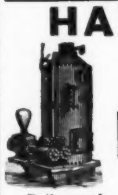

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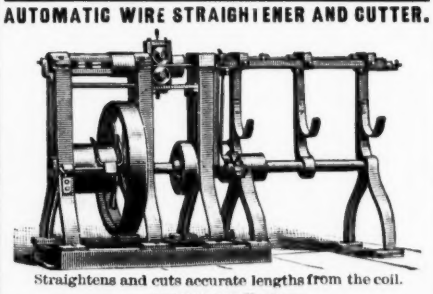

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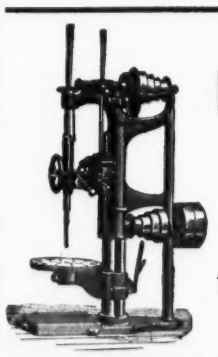

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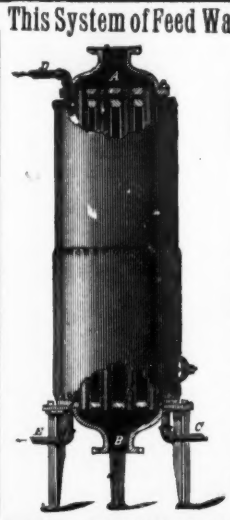

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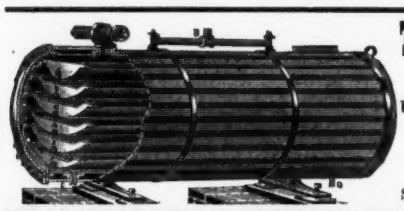

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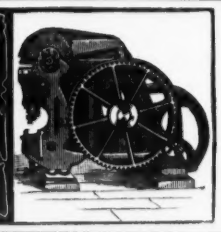

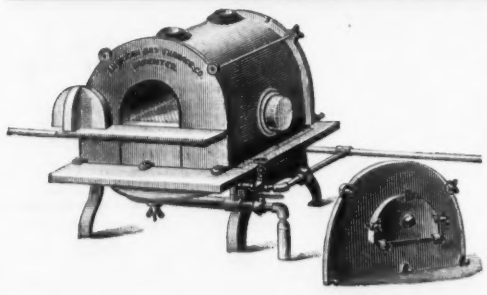

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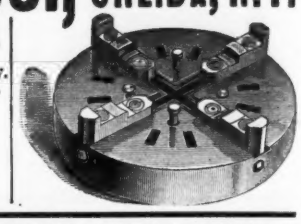

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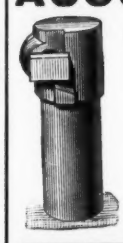

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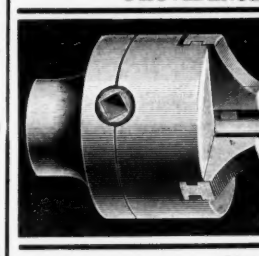

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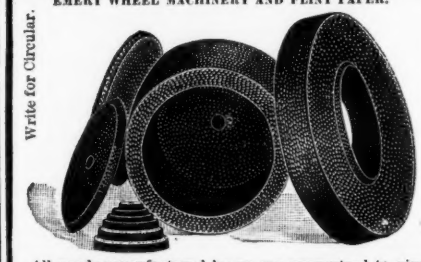

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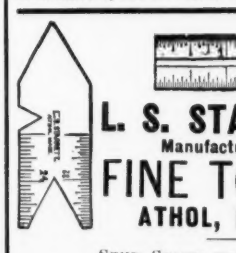

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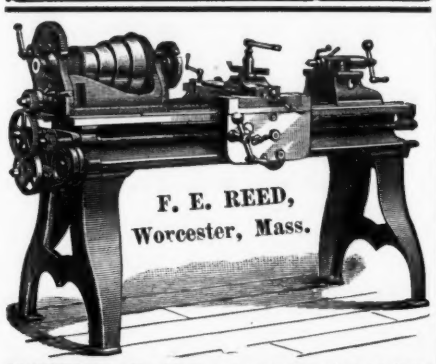

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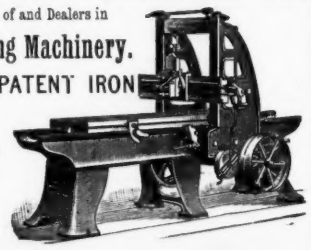

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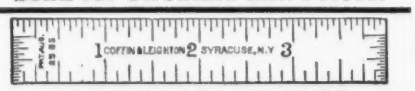

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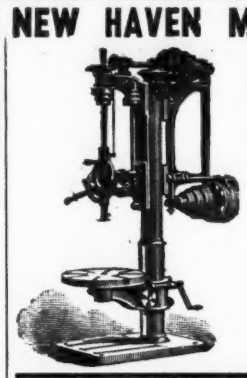

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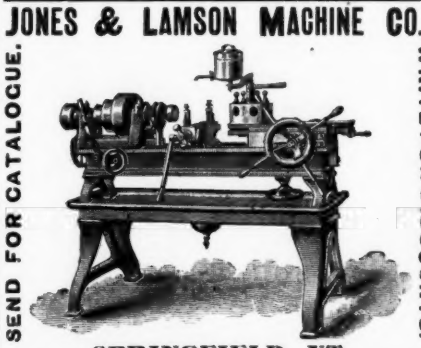

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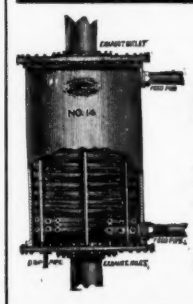

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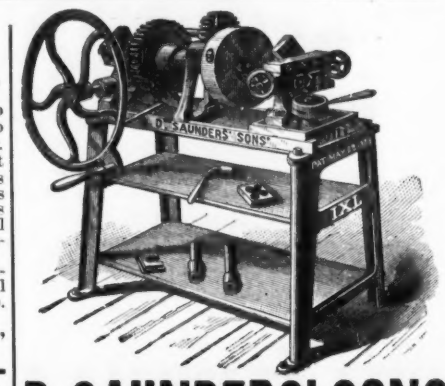

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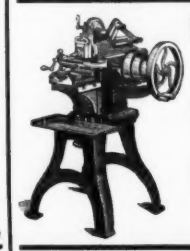

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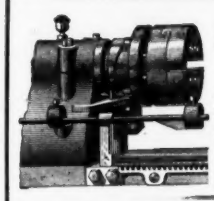

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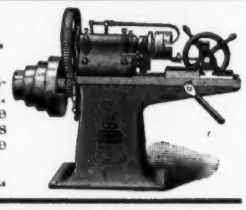

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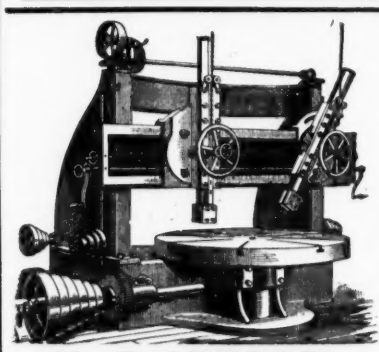

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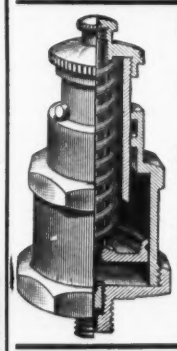

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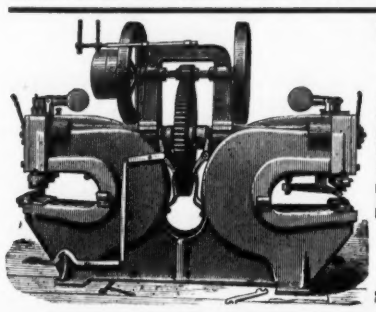

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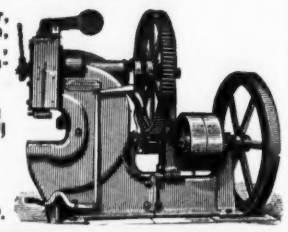

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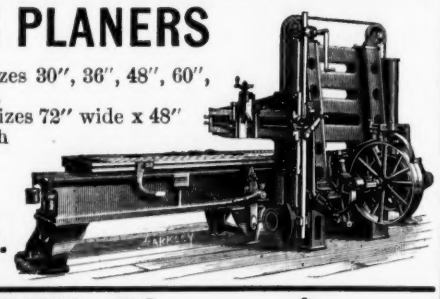

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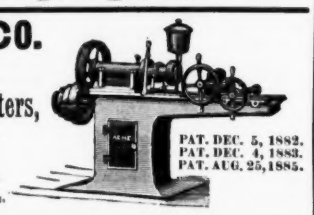

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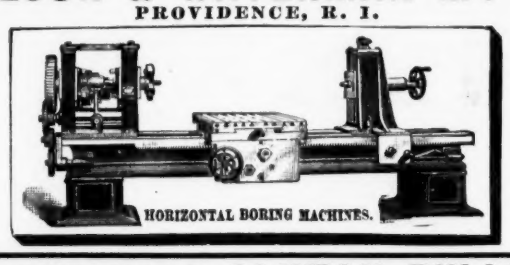
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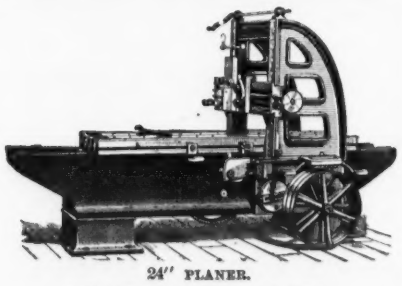
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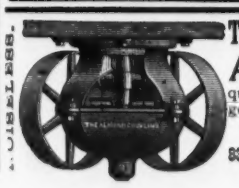
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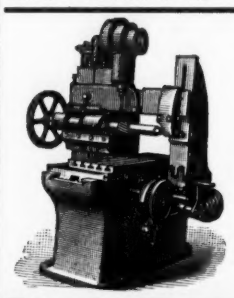

BEMENT, MILES & CO.,
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METAL-WORKING MACHINE TOOLS
FOR
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The HILLES & JONES CO., WILMINGTON, DELAWARE,
MANUFACTURERS OF
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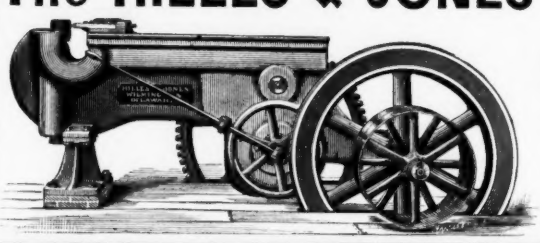
FOR
BOILER MAKERS, BRIDGE BUILDERS, SHIP BUILDERS, RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, ETC., ETC.



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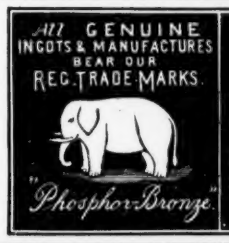

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INGOTS, CASTINGS & MANUFACTURES.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
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ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

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FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago; W. S. COLLINS, 171 Broadway, New York. CHILION JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. KALAMAZOO SPRING AND AXLE CO., Kalamazoo, Mich. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston.
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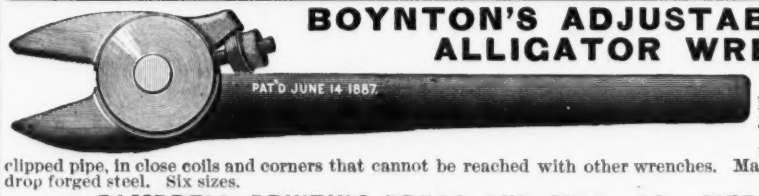
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.

BOYNTON'S ADJUSTABLE ALLIGATOR WRENCH.



Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. Six sizes.
CAMPBELL PRINTING PRESS AND MFG. CO., MFRS.
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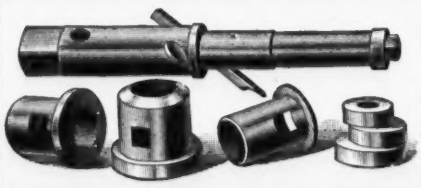
— THE —
Vance Lightning Flue Cutter



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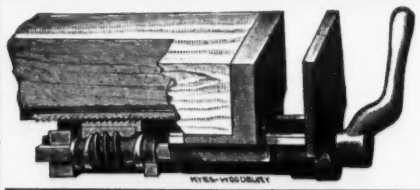
VANCE TUBE CUTTER CO., Geneva, N. Y.



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For Pattern Makers and Wood Workers.
WYMAN & GORDON,
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DROP FORGINGS.

BALL AUTOMATIC CUT-OFF ENGINES,
ERIE, PA.
The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.
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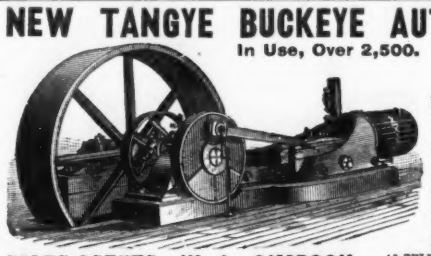
NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 2,500.

25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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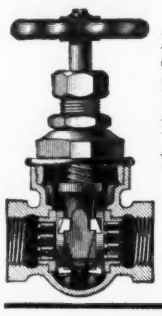
Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

BLESSING'S RENEWABLE-SEAT GLOBE, STRAIGHTWAY and CHECK VALVES.



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These valves are equally applicable to steam, water, or other fluid pressure.

We also manufacture **Blessing's Albany Steam Traps, Water Circulator and Purifier; and Pump Governor.**

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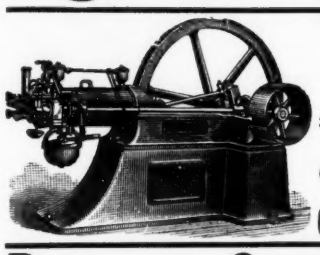

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OVER 25,000 ENGINES IN USE.

GUARANTEED To consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work.

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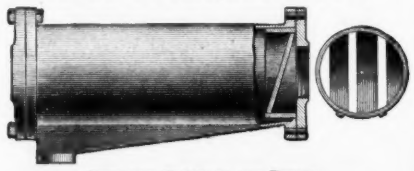

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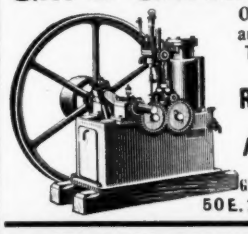

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RELIABLE AND ECONOMICAL.

Fully Warranted

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BEECHER & PECK. NEW HAVEN CONN.

DROP FORGINGS OF IRON OR STEEL

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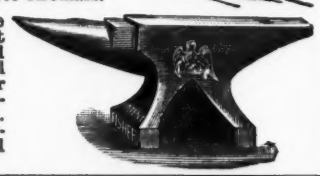

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NEW AND IMPROVED MILLING MACHINE.

☞ Note the following new features:
☞ Overhanging arm removed without taking off the sleeve.
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Cold Rolled Shafting in stock, all sizes.

Full line of new Machinery. Write for what you want.

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MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

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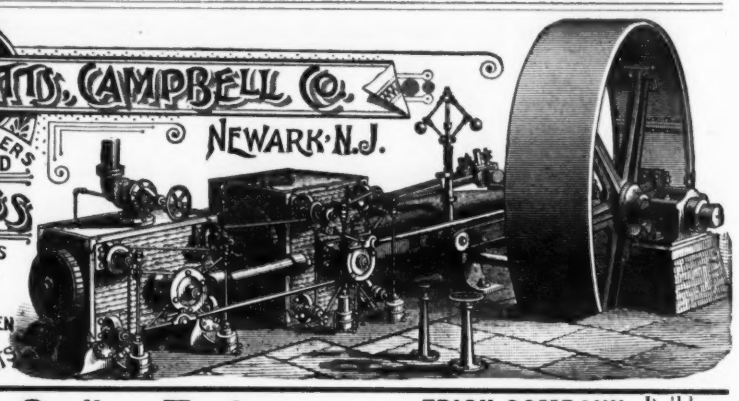
CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.



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NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

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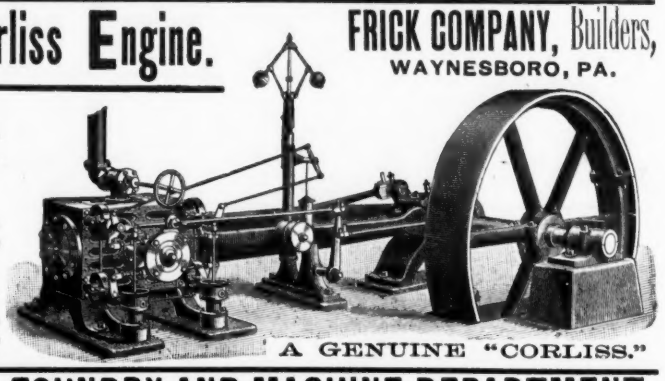

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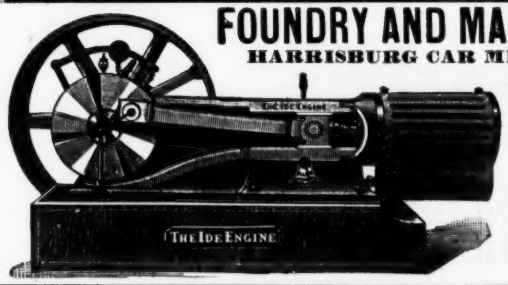

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We are operating the finest and most successful Electric Light Stations in the world. A change of speed not exceeding one per cent. guaranteed, running light and loaded. Send for catalogue.

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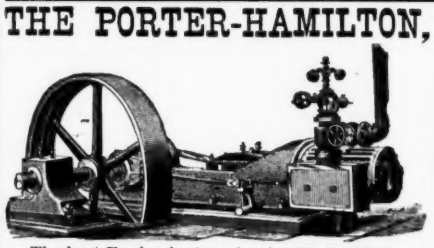

The best Engine in America for Heavy Work.

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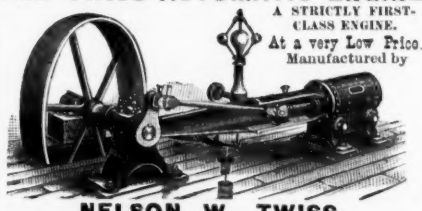
A STRICTLY FIRST-CLASS ENGINE.

At a very Low Price. Manufactured by



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Send for Price before Purchasing Elsewhere.

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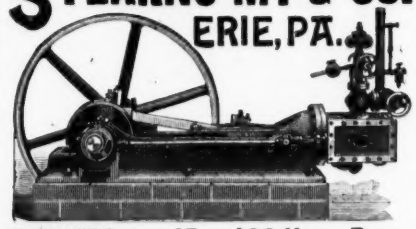

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Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

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WORKING DRAWINGS.

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WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

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A Very Desirable Lot of Machinery,

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MODERN STYLE. FIRST CLASS ORDER.

1 Bement 60 in. Hor. Boring Machine.
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THOMAS P. SIMPSON, Washington, D. C. No atty's fee until Patent obtained. Write for Inventor's Guide.

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SCREW CUTTING, GRINDING AND EXTRA FINE WORK.

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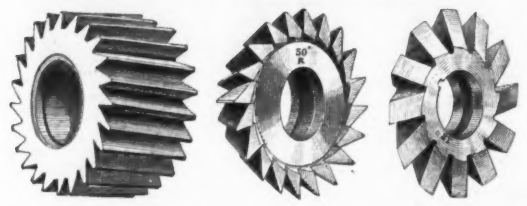

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FOR USE ON
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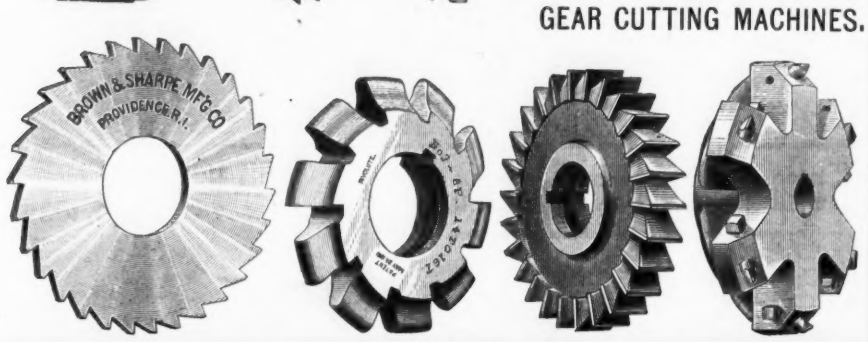

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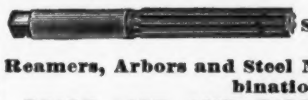
Manufacture Standard Size
Cylindrical and Caliper Gauges,
And End Measure Test Pieces.
Straight and Taper Solid Hand Reamers, Chucking and Shell Reamers, Arbors and Steel Mandrels, Taper Pin Reamers, Combination Lathe Chuck.



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MANUFACTURERS OF
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1¼, 2¼, 3¼, 4½, 6½ inches.

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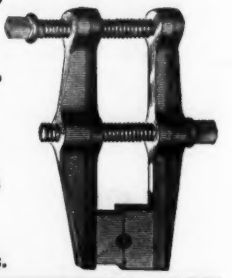

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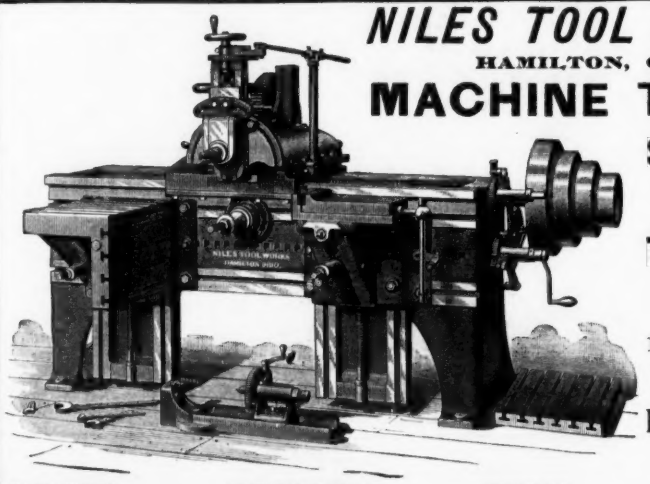
MACHINE TOOLS.



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Extra heavy and powerful.

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IRON and BRASS WORK.
CLEVELAND, OHIO.
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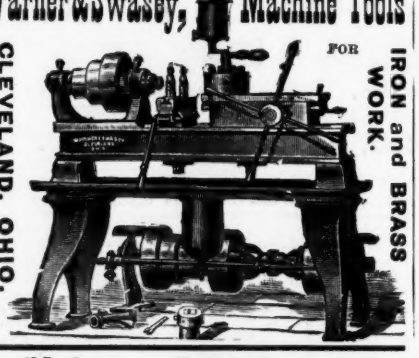

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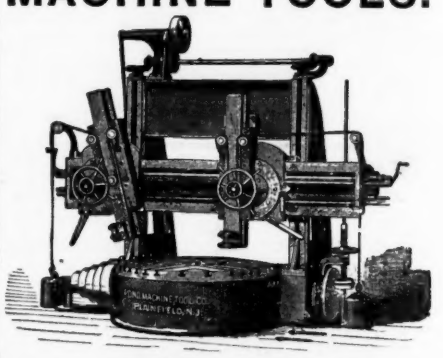

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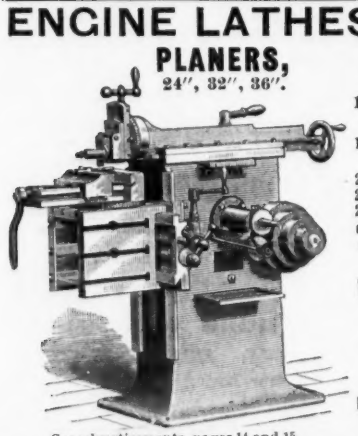

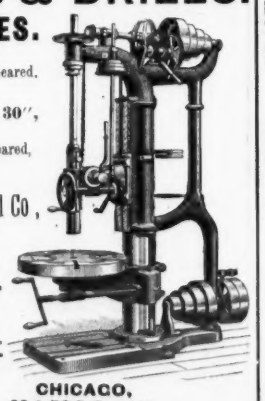

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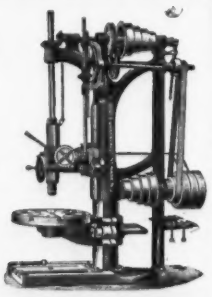

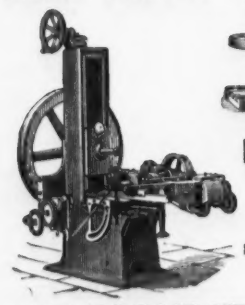

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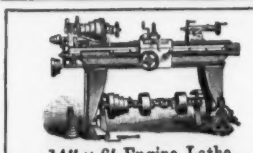
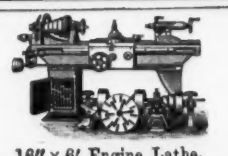
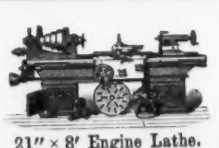

14″ × 6′ Engine Lathe.


16″ × 6′ Engine Lathe.


21″ × 8′ Engine Lathe.

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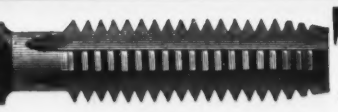

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